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SATURN S-I-10 STATIC TEST VIBRATION AND ACOUSTIC DATA

By MEASURING AND EVALUATION SECTION

NASA

George C. Marshall Space Flight Center, Huntsville, Alabama

TECHNICAL MEMORANDUM X-53377

SATURN S-I-10 STATIC TEST VIBRATION AND ACOUSTIC DATA

By

Measuring and Evaluation Section

George C. Marshall Space Flight Center
Huntsville, Alabama

ABSTRACT

This final report contains a synopsis of the vibration and acoustic data obtained from the static tests of Saturn vehicle S-I-10. The data is presented in terms of acceleration versus frequency, sound pressure level versus frequency, and statistical profiles. These presentations establish the statistical deviation of abnormal environmental parameters measured during static testing.

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TECHNICAL MEMORANDUM X-53377

SATURN S-I-10 STATIC TEST

VIBRATION AND ACOUSTIC DATA

By

Measuring and Evaluation Section

VIBRATION AND ACOUSTICS BRANCH
STRUCTURES DIVISION
PROPULSION AND VEHICLE ENGINEERING LABORATORY
RESEARCH AND DEVELOPMENT OPERATIONS

FOREWORD

This report was prepared by Chrysler Corporation Space Division, Huntsville Operations, Structures Branch of the Structures and Mechanics Engineering Department, for the George C. Marshall Space Flight Center, Propulsion and Vehicle Engineering Laboratory, Structures Division, Vibration and Acoustics Branch, under Contract NAS8-4016, Mod. 80, Task Assignment 20.

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Telemetered Data (Continued)

MEAS. NUMBER	MEASUREMENT DESCRIPTION	MEAS. LOC. FIG. NO.	REDUCED DATA FIG. NO.
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Hardwire Data

MEAS. NUMBER	MEASUREMENT DESCRIPTION	MEAS. LOC. FIG. NO.	REDUCED DATA FIG. NO.
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82.03A-3	Turbine Gear Box (Fuel Side), Lat.	A-1	B-81
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84.001-3	Upper Bulkhead F-3, Perp. to Surface	A-8	B-37

MEAS. NUMBER	MEASUREMENT DESCRIPTION	MEAS. LOC. FIG. NO.	REDUCED DATA FIG. NO.
84.001A-3	Upper Bulkhead F-3, Perp. to Surface	A-8	B-38, 95
84.002-3	Upper Bulkhead F-3, Parallel to Surface	A-8	B-39
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Hardwire Data (Continued)

MEAS. NUMBER	MEASUREMENT DESCRIPTION	MEAS. LOC. FIG. NO.	REDUCED DATA FIG. NO.
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84.0012	Shroud, Perp.	A-11	B-58, 102
84.0013	Shroud Panel, Perp.	A-11	
84.0014	Skin F-1, Perp.	A-11	B-59
84.0015	Spider Beam, Pitch	A-8	B-45, 103
84.0016	Spider Beam, Yaw	A-8	B-46, 104
84.0017	Spider Beam, Long't	A-8	B-47, 105
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84.0026-4	Skin F-4, Perp. to Tank Skin	A-11	B-60, 106
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Hardwire Data (Continued)

MEAS. NUMBER	MEASUREMENT DESCRIPTION	MEAS. LOC. FIG. NO.	REDUCED DATA FIG. NO.
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88.012	F-2 Instrument Compartment	A-13	B-66
88.013	F-2 Instrument Compartment	A-13	B-67
88.014	Instrument Panel F-2	A-13	B-68
88.015	Instrument Panel F-2	A-13	B-69
88.016	Instrument Panel F-2	A-13	B-70
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89.602	F-1 Aft Skirt, Perp.	A-13	B-72
89.603	F-1 Aft Skirt, Lat.	A-13	B-73
89.604	F-1 Aft Skirt, Long't	A-13	B-74
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89.606	F-1 Aft Skirt	A-13	B-76
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89.60	Spider Beam	A-9	B-48
89.61	Spider Beam	A-9	B-49

TECHNICAL MEMORANDUM X-53377

SATURN S-I-10 STATIC TEST VIBRATION AND ACOUSTIC DATA

SUMMARY

The data obtained during the static testing of the S-I-10 vehicle indicated that all functional systems performed satisfactorily. In general, the response characteristics of the S-I-10 structure were normal for the static test condition, and no structural degradation was indicated. A discussion of anomalies in the structural response is presented where applicable.

Telemetry measurements on the thrust chamber domes were inconsistent with measurements using the hardwire system and are considered invalid. This problem has existed for the static tests of previous vehicles and studies are being made to determine the cause of the inconsistency. However, the results have been inconclusive thus far.

The hardwire vibration measurement at station 152, on the shroud skin was deleted for test SA1024. The repeated failure of the bonding of the transducer to the structure on static tests S-I-9, S-I-8, and S-I-10 has provided little usable data.

The telemetered internal acoustic measurement at station 171, on the thrust structure was invalid due to transients in the data. No hardwire acoustic measurements were made during these tests.

SECTION I. INTRODUCTION

The objectives of this report are to (1) provide a concise reference of vibration and acoustic data obtained during the static tests of the S-I-10 vehicle, and (2) to evaluate and interpret the reduced data, emphasizing abnormalities in the structural responses and the vibration and acoustic environment.

The Saturn S-I-10 stage was static tested on September 24, 1964 (Test Run SA1023) for a duration of 35.08 sec., and on October 6, 1964 (Test Run SA1024) for a duration of 149.93 sec. The data presented in this report were taken from the results of run SA1024 unless otherwise indicated.

The locations of applicable hardwire and telemetered vibration and acoustic measurements are provided in Appendix A. Appendix B presents the following definitions and information on the reduced data:

a. Definition of statistical parameters

b. Basic statistical parameters by measurement

c. Acceleration power spectral density plots

d. Acceleration amplitude versus frequency plots (10 cps bandwidth)

e. Pressure spectrum level plots

f. Predominant frequency versus rms acceleration amplitude

g. Measurement variance analysis plots

A statistical definition of the vibration environment is provided in terms of mean value, standard deviation, kurtosis, chi-square, and skewness for each measurement. These parameters are used to define the degree of randomness, or periodicity, of the structural response. The meaning of each statistical parameter is given in terms of its application to data evaluation.

The vibratory response of each structural location is described in terms of acceleration spectral density (G^2/cps) as a function of frequency (cps), or 10 cps bandwidth rms acceleration (G_{rms}) as a function of frequency. The acoustic environment is described in terms of pressure spectrum level (PSL) in dB, referenced to a pressure of $2 \times 10^{-5} N/m^2$, as a function of frequency. The ten most predominant frequencies are tabulated in descending order of the corresponding rms acceleration (G_{rms}) amplitudes.

The measurement analysis compares each current measurement spectrum (heavy starred line) with the normal or mean spectra established from the same measurement on previous tests. Two other envelopes besides the mean are presented. These envelopes establish the degree of variance between the SA1024 data and the 87.5 percent and 95 percent confidence levels of previous data. (See FIG. B-1 for an example.) Measurement analysis plots are shown in FIG. B-1 through B-107.

Appendix C includes (1) a block diagram of the data acquisition and reduction systems, (2) a table for comparison of composite rms vibration amplitudes, and (3) static test measurement discrepancies in tabular form.

SECTION II. INSTRUMENTATION SYSTEMS

A. Hardwire

The instrumentation system for the acquisition of the hardwire vibration and acoustic data included a transducer, cathode follower, coaxial cable, amplifier, and tape recorder.

The accelerometers used in the hardwire instrumentation system of the Saturn S-I-10 vehicle were as follows:

TYPE	MODEL	FUNDAMENTAL RESONANT FREQUENCY (cps)
Cubic	2A507	above 5000
Cubic	3A509	5000
Statham	A6-15-350	150
Glennite	A45U	above 5000

The hardwire instrumentation system provided a reasonably flat frequency response over the range from 0 to 5000 cps, as required, except for the low frequency (Statham) accelerometers.

The instrumentation and calibration ranges used at each measurement location are presented in Table IV-a.

B. Telemetered

The instrumentation systems for the acquisition of the telemetered vibration and acoustic data included a transducer, cathode follower, multiplexer, SSB/FM telemetry transmitter and receiver, amplifier, and tape recorder.

The transducers used in the telemetry instrumentation system of the Saturn S-I-10 vehicle were:

TYPE	MODEL	FUNDAMENTAL RESONANT FREQUENCY (cps)
Gulton	TA501UA	Above 5000
Glennite	AT1289	Above 5000
Gulton	MA299501	Above 5000

The systems provided a reasonably flat response over the range from 100 to 2500 cps, as required.

The instrumentation and calibration ranges used at each measurement location are presented in Table IV-b.

C. Data Reduction

One system for the data reduction of hardwire vibration and acoustic data included a tape loop transport, narrowband swept filter (nominal bandwidth of 10 cps), spectrum wave analyzer, and plotter. The amplitude (G_{rms}) versus frequency plots were obtained with a spectrum wave analyzer employing a 10-cps narrow bandwidth filter swept at the rate of 1.8 cps/sec and with an averaging time constant of 2.5 sec.

Another system consisted of an analog-to-digital (a-to-d) converter, tape recorder, digital computer, and plotter.

The system used for the data reduction of the telemetered vibration and acoustic data consisted of a demultiplexer, tape recorder, a-to-d converter, digital computer, and plotter. The demultiplexer comprised a discriminator that contained variable bandpass and low-pass filters. Block diagrams of the data acquisition and data reduction systems described above are given in Table I (Appendix C).

SECTION III. VIBRATION DATA

A total of 55 hardwire and 24 telemetered high frequency vibration measurements were taken during S-I-10 static tests.

Additional low frequency vibration measurements were made through the telemetry system. However, these transducers were used to

define bending modes and are not included in this report.

A. Engine Domes

Hardwire measurements: 81.041-1 through 81.041-8

Telemetered measurements: E33-1, E33-3, E33-5, E33-7, E11-2, E11-4, E11-6, E11-8

Structural response:

Thrust chamber dome response, obtained from hardwire measurements, was consistent with previous hardwire data and indicated normal engine performance.

Anomalies:

The past history of the longitudinal measurements (E33-1, E33-3, E33-5, E33-7) of the vibration of the combustion chamber domes has shown discrepancies between telemetered and hardwire data. The amplitudes measured by the telemetry system have consistently been two to four times greater than those measured by the hardwire system. An examination of the two systems indicates that the telemetry data from these measurements are invalid.

Two of the lateral measurements (E11-2, E11-4) exhibited abnormally high amplitudes and are considered invalid. Also, transients were noted in three of the measurements (E11-4, E33-3, E33-7). No data were obtained from hardwire measurement 81.041-5 in test SA1024 because measurements were invalid after 5.5 sec. This was the result of a defective transducer connecting cable.

B. Engine Gear Case (Turbopumps)

Hardwire measurements: 82.03A1 through 82.03A-8
82.03D-1 through 82.03D-8

Telemetered measurements: E12-1 through E12-8

Structural response: Normal

The spectra of the engine gear box vibration were characterized by high amplitudes at discrete frequencies. In some

instances the amplitudes exceeded the accepted norm; however, no degradation was indicated by these data.

Anomalies: None

NOTE:

1. The letter "A" denotes hardwire measurements on the fuel side of the gear case; the letter "D" measurements were made on the LOX side of the gear case.

2. The telemetered vibration measurements on engines one, two, three, and four were repetitions of previous firings. The measurements on engines five, six, seven, and eight were made for the first time on tests SA1023 and SA1024. Therefore, the variance plots represent a comparison of these two firings only.

C. Fuel Interconnect Line

Hardwire measurements: 84.007-3, 84.008-3, 84.009-4, 84.0024-4

Telemetered measurements: None

Structural response:

The response of the fuel interconnect line was characteristically low amplitude.

Anomalies:

The data were affected by electrical noise, particularly near 60 cps.

D. Shear Beam/Panels

Hardwire measurements: 81.300 through 81.311

Telemetered measurements: E135-9, E139-9, E140-9

Structural response: Normal

The response patterns of the shear beam and panels were consistent with those observed during previous firings.

The unbraced panels exhibited significant response approximately every 100 cps below 1 kc. The vibration of the stiffened panel was characterized by lower response amplitudes.

Anomalies: None

E. Shroud Panel

Hardwire measurements: 84.0011, 84.0012, 84.0013

Telemetered measurements: None

Structural response: Normal

Anomalies:

Measurement 84.0013 was lost in test SA1023 and all previous static firings due to ineffective bonding. This measurement was deleted from test SA1024.

F. Fuel Tank Skin

Hardwire measurements: 84.0014, 84.0026, 84.0027

Telemetered measurements: None

Structural response: Normal

The vibration level at the upper measurement location was considerably greater than at the two lower measurement locations. This was attributed to the propellant level in the tank being below the upper measurement location during the time analyzed.

Anomalies:

Measurement 84.0027 was not available in test SA1024 due to ineffective bonding of the transducer to the structure.

G. Fuel Tank Upper Bulkheads

Hardwire measurements: 84.001 through 84.004
84.001A through 84.004A

Telemetered measurements: None

Structural response: Normal

The vibratory response of the upper bulkheads was highest in the frequency range of 250 to 1,500 cps. The characteristic response at 2 kc was also present for the SA-10 test firings. The vibration levels of fuel tanks F-3 and F-4 persisted at approximately one-third the mainstage level after engine cutoff. This phenomenon was attributed to fuel tank venting after cutoff.

Anomalies: None

NOTE:

1. Measurements 84.001 through 84.004 were made with low frequency transducers providing data below 100 cps. The measurements with the "A" notation provided information to 5 kc.

H. Fuel Tank Lower Bulkheads

Hardwire measurements: 84.005, 84.005A, 84.006A

Telemetered measurements: None

Structural response: Normal

Anomalies: None

NOTES:

1. Measurement 84.005 was made with a low frequency transducer providing information below 100 cps.

2. The vibration response amplitude increased as the fuel in the tank was depleted.

I. Distributor 9A3

Hardwire measurements: None

Telemetered measurement: E270-9

Structural response: Normal

Anomalies: None

NOTES:

1. Although the description of this measurement is given as "Distributor 9A3 Mounting Bracket," the transducer was mounted on the Z-ring in the aft skirt of fuel tank No. 1 adjacent to the mounting bracket.

J. Spider Beam

Hardwire measurements: 84.0015, 84.0016, 84.0017

Telemetered measurements: E105-11, E107-11

Structural response: Normal

Anomalies:

Measurement 84.0017 provided questionable data throughout most of both tests. However, the data during the slice time presented were considered to be valid.

K. Heat Shield Panels (S-IB)

Hardwire measurements: 83.32, 86.33, 86.34

Telemetered measurements: None

Structural response:

These vibration measurements were made on S-IB-type honeycomb heat shield panels. Since measurements were not made on this structure previously, an evaluation of the response characteristics by direct comparison was not possible. The response of the structure was characterized by a relatively flat spectrum above 500 cps and a predominant response of approximately 130 cps.

Anomalies: None

L. F-2 Instrument Compartment

Hardwire measurements: 88.011, 88.012, 88.013
88.014, 88.015, 88.016

Telemetered measurements: None

Structural response: Normal

The measurements in the F-2 instrument compartment were not made during the previous static tests. The composite vibration levels of measurements 88.011 through 88.013, mounted on the power distributor 12A25, were approximately 1 G_{rms}. The levels on the instrument compartment skin were nearly 3 G_{rms}. The predominant response of the power distributor was 25 cps; however, this is near the low end of the range over which the frequency can be analyzed and is not considered valid. The predominant response of the skin occurred at frequencies of 500 and 2000 cps.

Anomalies:

The frequency response at 25 cps for measurements 88.011, 88.012, and 88.013 was near the lower limit of the linear response of the instrumentation system and was considered invalid.

M. F-1 Aft Skirt

Hardwire measurements: 89.601, 89.602, 89.603, 89.604, 89.605, 89.606, 89.607

Telemetered measurements: None

Structural response: Normal

The vibration response on and adjacent to the voltage regulator 40C20002 was measured in both tests SA1023 and SA1024. The instrumentation on previous static firings did not include measurements at these locations; therefore, direct comparisons were not possible. The vibration response of the voltage regulator was greatest (5 G_{rms})perpendicular to the mounting surface. The predominant frequency in all three planes was 100 cps. The vibration of the tank skin adjacent to the voltage regulator was 8 G_{rms}.

Anomalies: None

SECTION IV. ACOUSTIC DATA

All hardwire acoustic measurements and all but one telemetered acoustic measurement were deleted from the S-I-10 static tests.

Hardwire measurements: None

Telemetered measurement: L28-9

Acoustic environment:

The internal acoustic environment was invalid.

Anomalies:

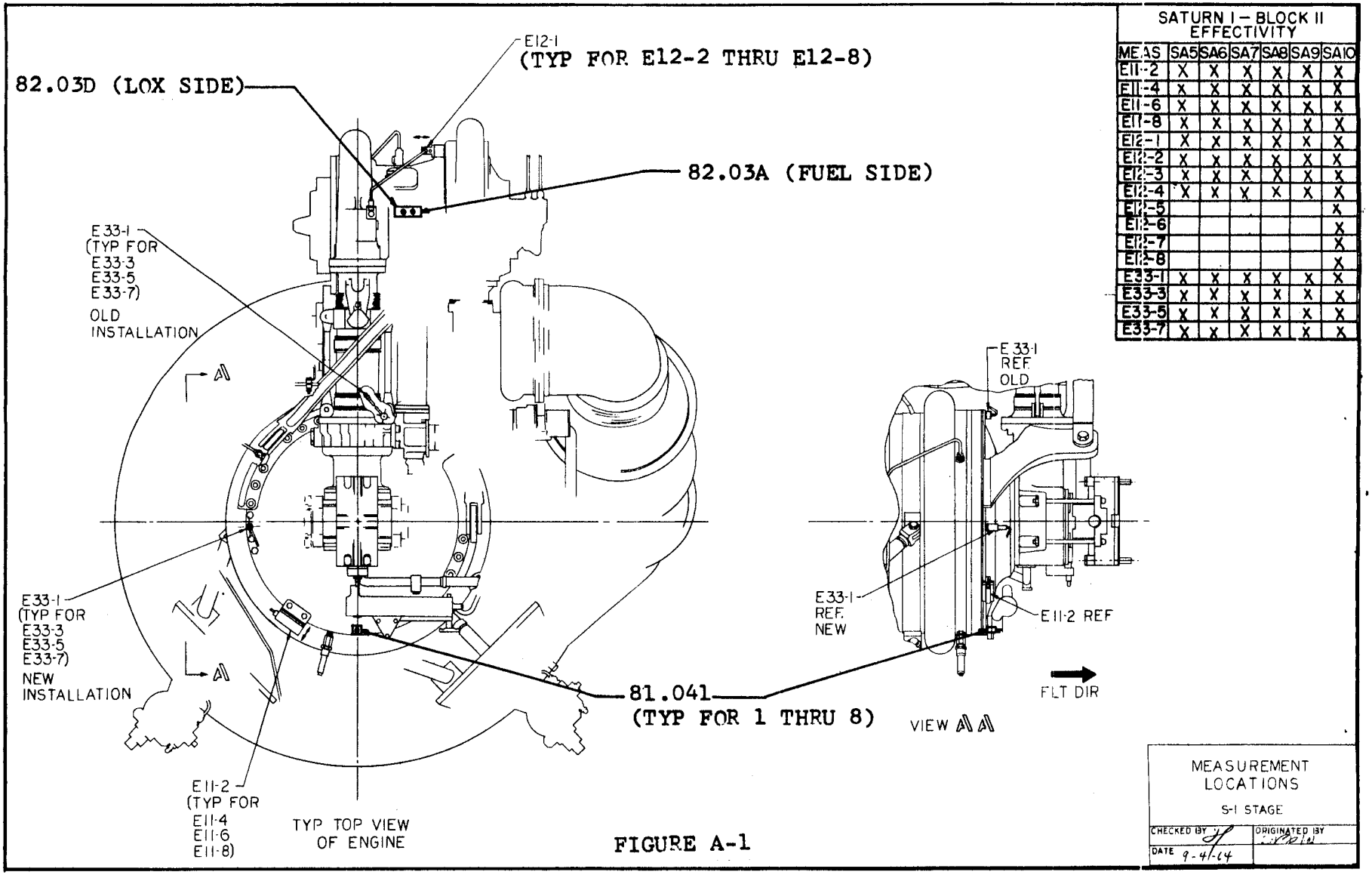
The internal acoustic environment was considered invalid due to transients in the data.

APPENDIX A

MEASUREMENT LOCATIONS

Telemetered Measurements ---------- Figures A-1 through A-6

Hardwire Measurements ---------- Figures A-7 through A-14

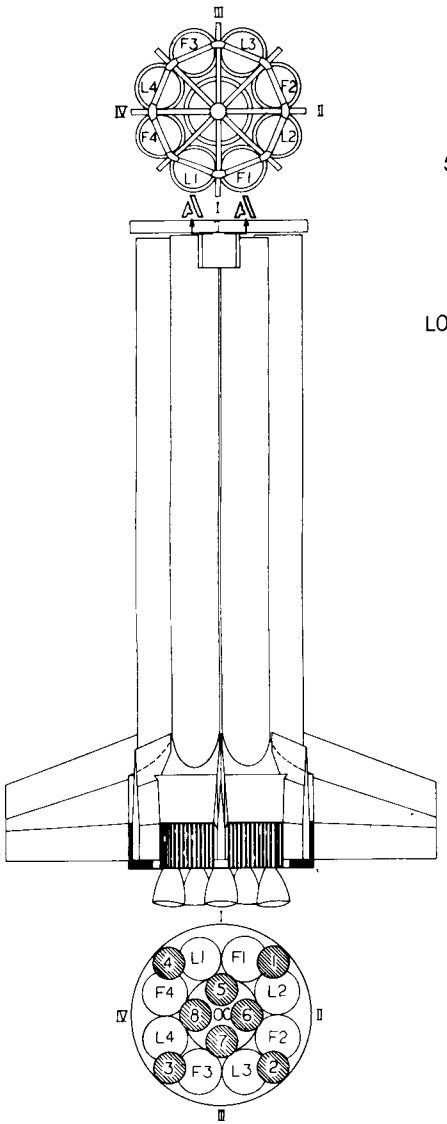


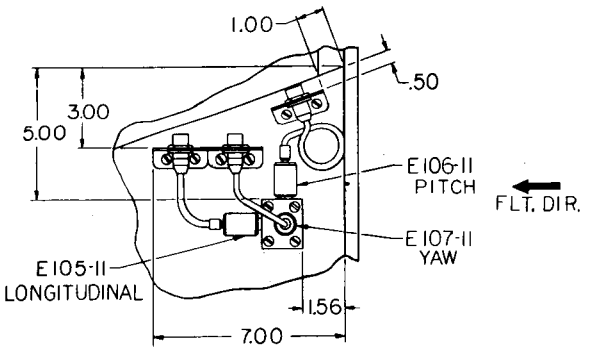
SATURN I – BLOCK II EFFECTIVITY						
MEAS	SA5	SA6	SA7	SA8	SA9	SA10
E11-2	X	X	X	X	X	X
E11-4	X	X	X	X	X	X
E11-6	X	X	X	X	X	X
E11-8	X	X	X	X	X	X
E12-1	X	X	X	X	X	X
E12-2	X	X	X	X	X	X
E12-3	X	X	X	X	X	X
E12-4	X	X	X	X	X	X
E12-5						X
E12-6						X
E12-7						X
E12-8						X
E33-1	X	X	X	X	X	X
E33-3	X	X	X	X	X	X
E33-5	X	X	X	X	X	X
E33-7	X	X	X	X	X	X

MEASUREMENT LOCATIONS	
S-I STAGE	
CHECKED BY	ORIGINATED BY
DATE 9-4-64	

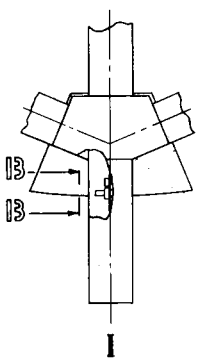
FIGURE A-1

SATURN I - BLOCK II EFFECTIVITY						
MEAS	SA5	SA6	SA7	SA8	SA9	SA10
E105-II	X	X	X	X	X	X
E106-II	X	X	X	X	X	
E107-II	X	X	X	X	X	X





VIEW 13 13



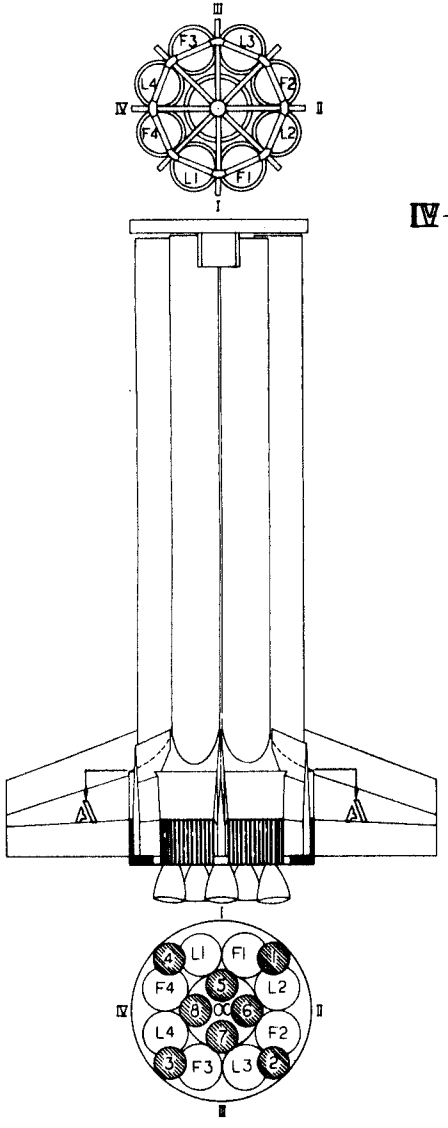
SECTION AA

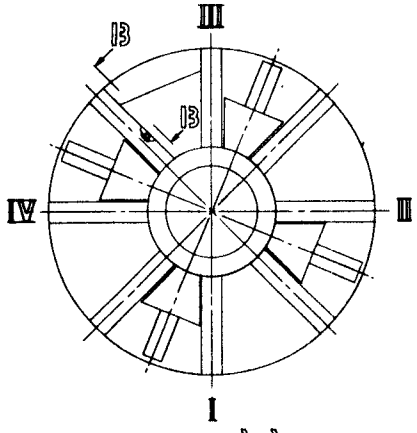
FIGURE A-2

MEASUREMENT LOCATIONS

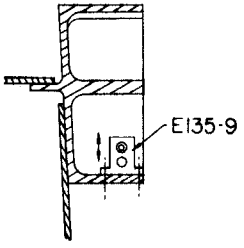
S-I STAGE

CHECKED BY	ORIGINATED BY
DATE 9-4-64	



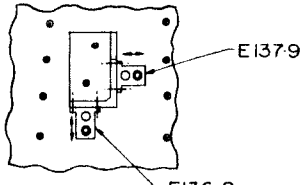


SECTION A A

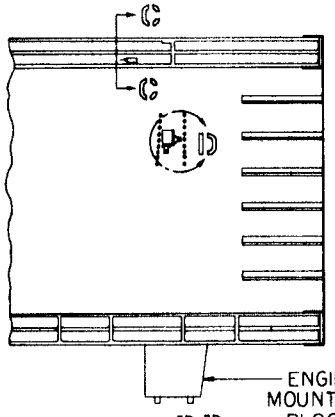


SECTION C C

FLT DIR



DETAIL D



SECTION B B
ROTATED 112½°CW

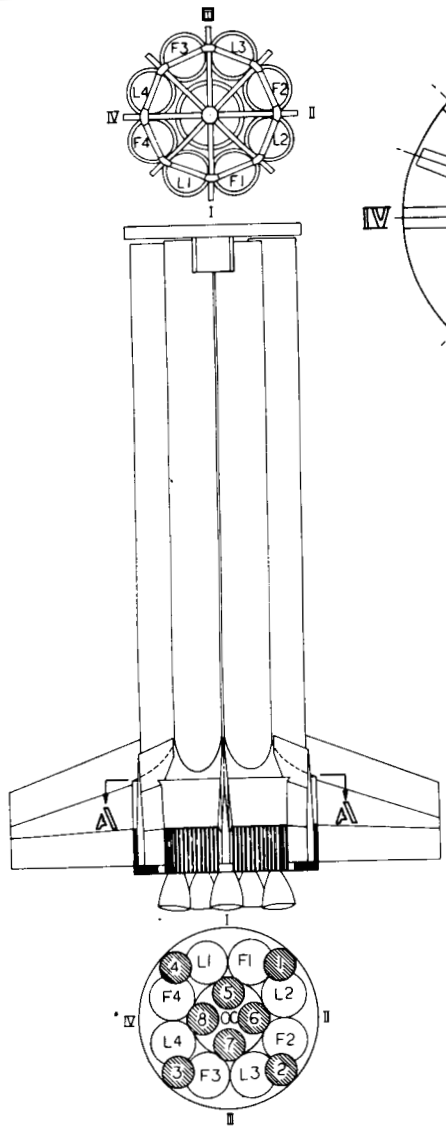
SATURN I - BLOCK II EFFECTIVITY						
MEAS.	SA5	SA6	SA7	SA8	SA9	SA10
E135-9	X	X	X	X	X	X
E136-9	X	X	X	X	X	X
E137-9	X	X	X	X	X	

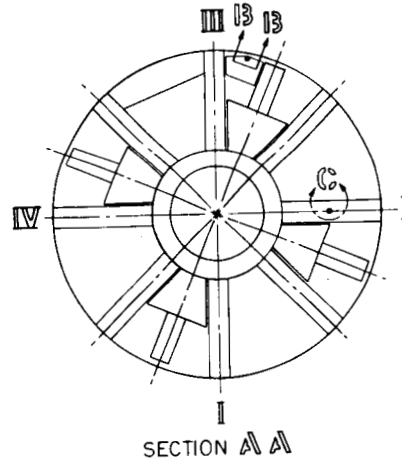
FIGURE A-3

MEASUREMENT LOCATIONS	
S-I STAGE	
CHECKED BY	ORIGINATED BY
DATE 9-4-64	

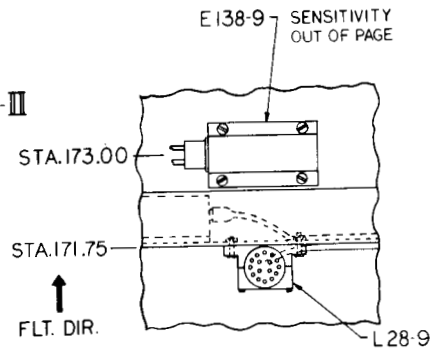
SATURN I - BLOCK II
EFFECTIVITY

MEAS	SA5	SA6	SA7	SA8	SA9	SA10
E138-9	X	X	X	X	X	
E363-6	X	X	X	X		
L28-9	X	X		X	X	X

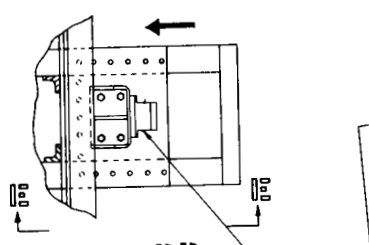




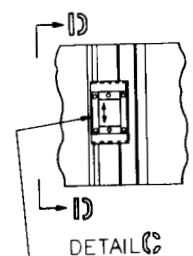
SECTION A A



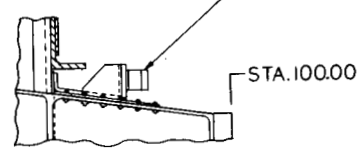
SECTION B B



VIEW D D



DETAIL C

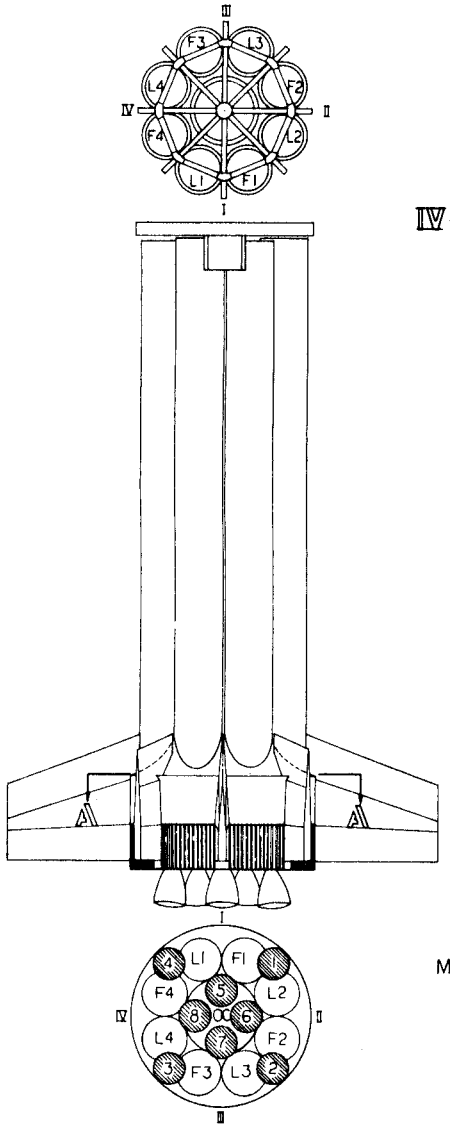


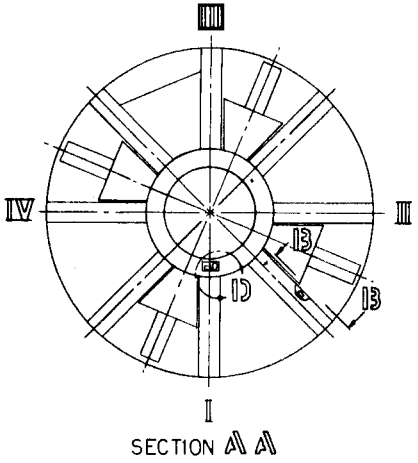
VIEW E E

FIGURE A-4

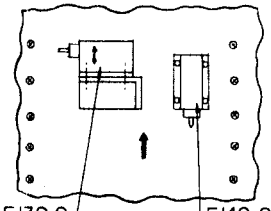
MEASUREMENT LOCATIONS
S-I STAGE

CHECKED BY H
ORIGINATED BY
DATE 9-4-64

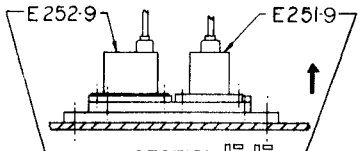




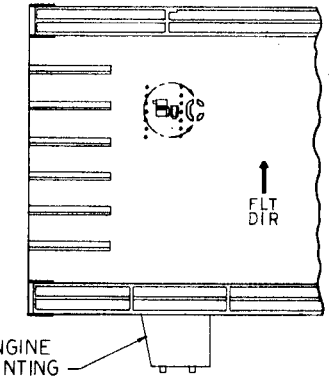
SECTION A A



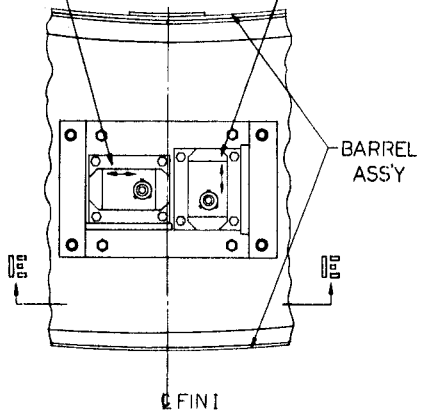
DETAIL C



SECTION B B



VIEW B B



DETAIL D

FIGURE A-5

SATURN I - BLOCK II
EFFECTIVITY

MEAS	SA5	SA6	SA7	SA8	SA9	SA10
E139-9	X	X	X	X	X	X
E140-9	X	X	X	X	X	X
E251-9	X	X	X			
E252-9	X	X	X			

MEASUREMENT
LOCATIONS
S-I STAGE

CHECKED BY	ORIGINATED BY
DATE 9-4-64	

SATURN I - BLOCK II EFFECTIVITY						
MEAS	SA5	SA6	SA7	SA8	SA9	SA10
E269-9	X	X	X	X	X	
E270-9	X	X	X	X	X	X

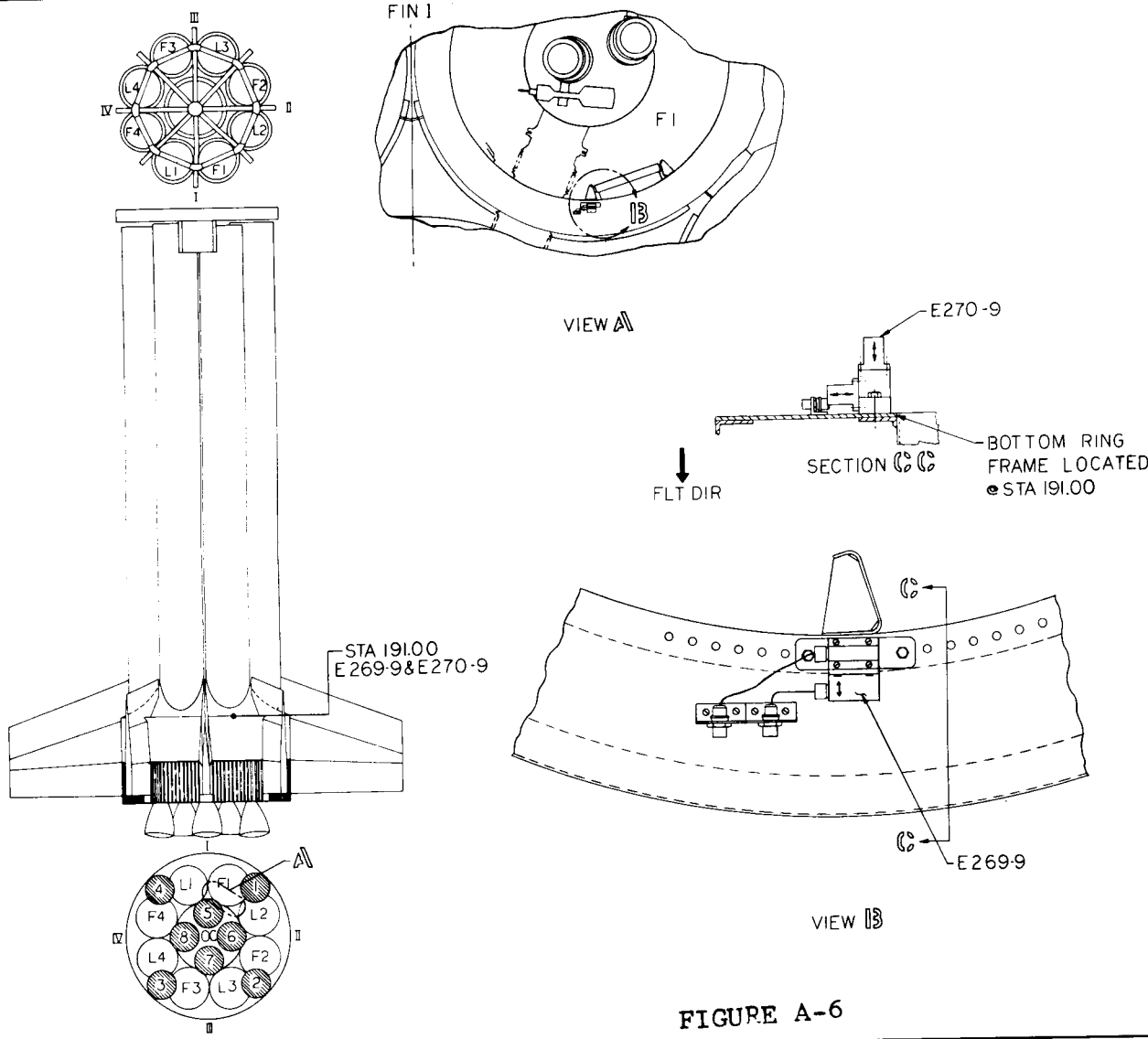
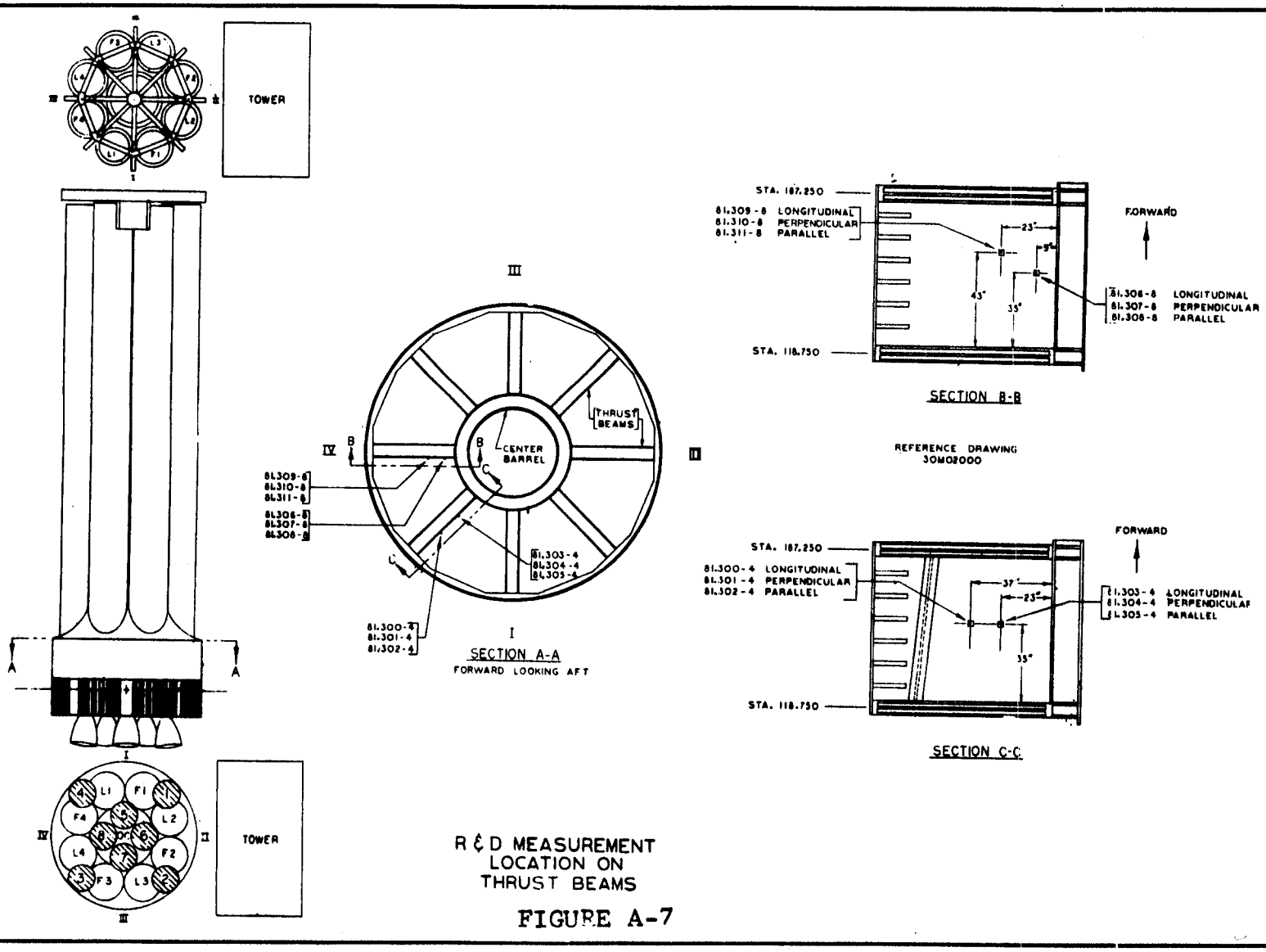
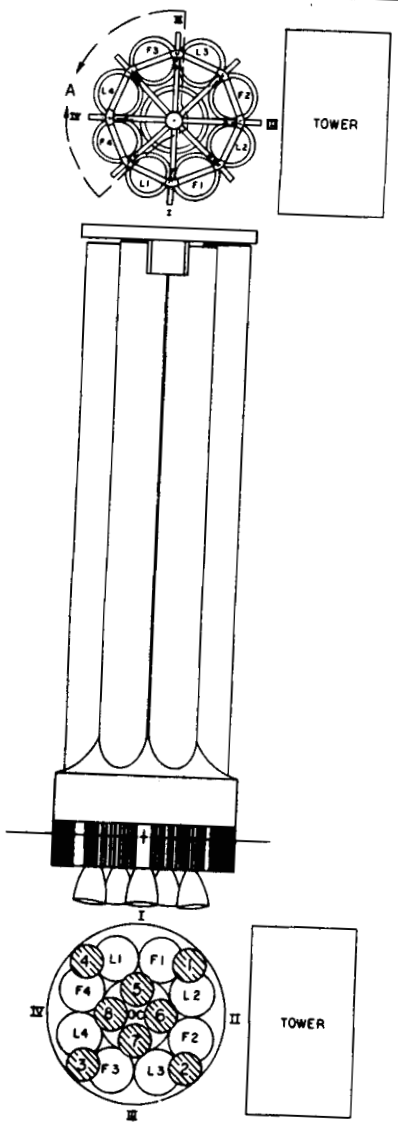


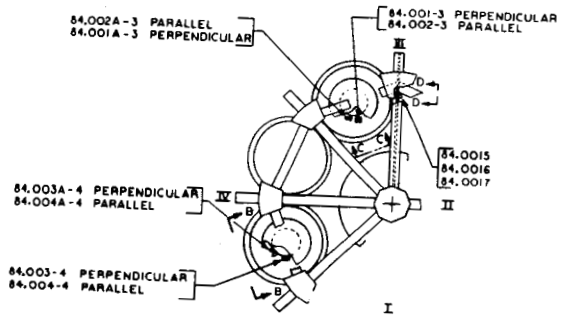
FIGURE A-6



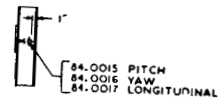
R & D MEASUREMENT
LOCATION ON
THRUST BEAMS

FIGURE A-7

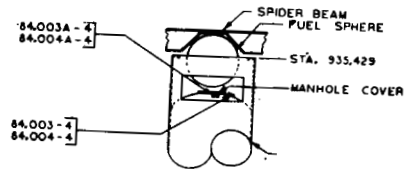




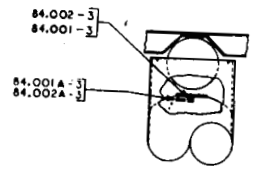
DETAIL "A"



SECTION D-D



VIEW B-B
(ROTATED 67 1/2° CCW)

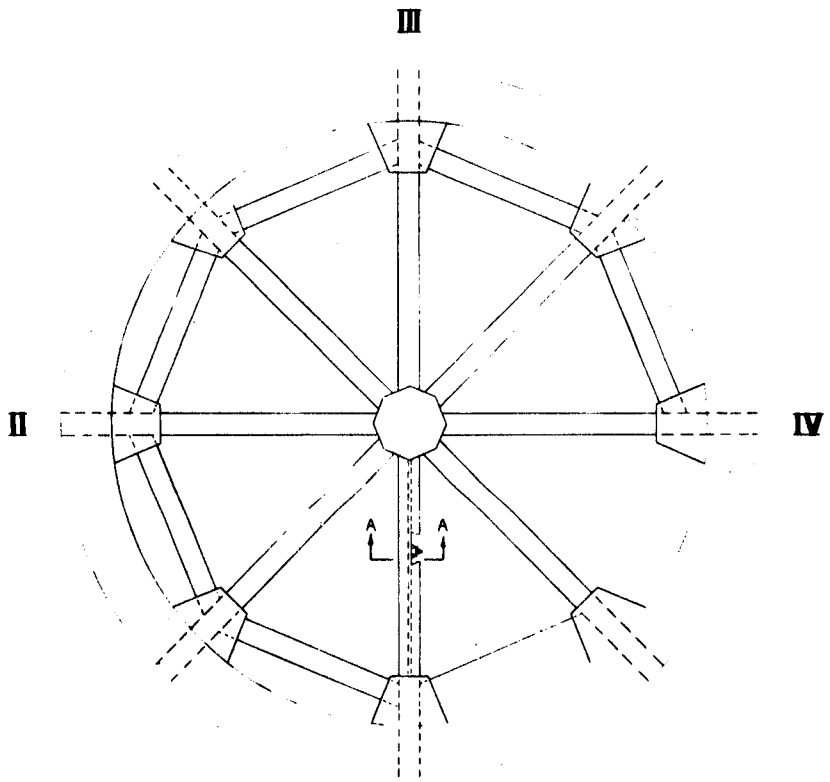


VIEW C-C
(ROTATED 22-1/2° CW)
(SAME AS B-B EXCEPT AS SHOWN)

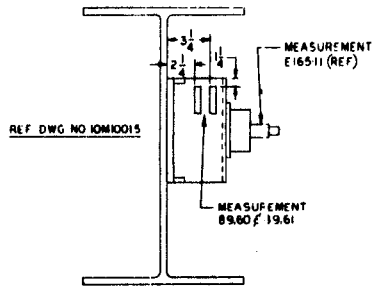
NOTE ;
1. REF. DWG. NO. 10M10003
2. TRANSDUCERS ON F-3 & F-4 ARE APPROX. 1" FROM MANHOLE COVERS.

R & D MEASUREMENT LOCATION ON UPPER TANKS & SPIDER BEAM

FIGURE A-8



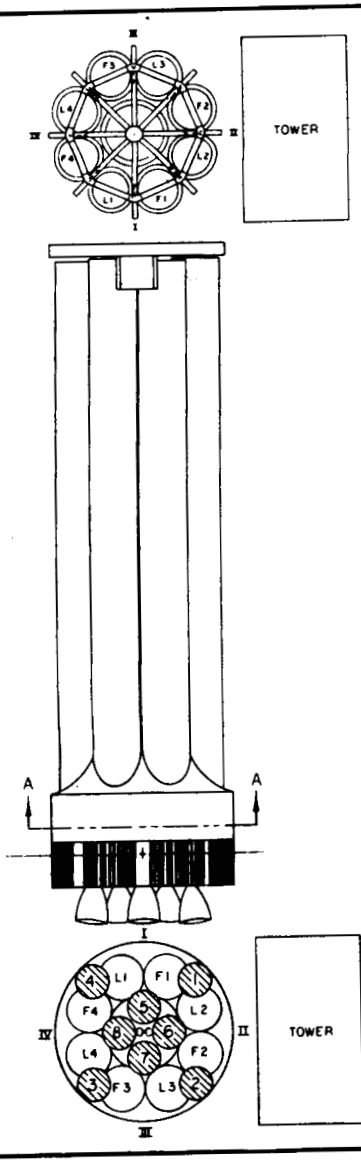
VIEW LOOKING AFT
TOP OF SPIDER BEAM

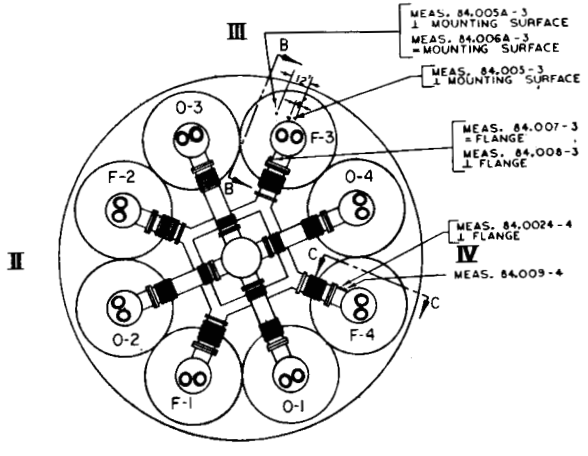


SECTION A-A

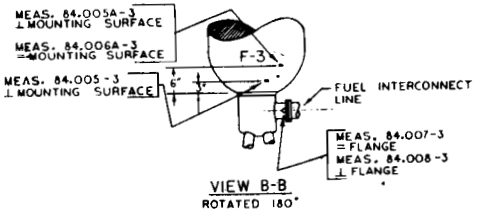
R & D MEASUREMENT
LOCATION ON
SPIDER BEAM

FIGURE A-9

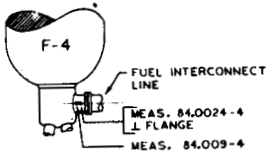




SECTION A-A
AFT LOOKING FORWARD



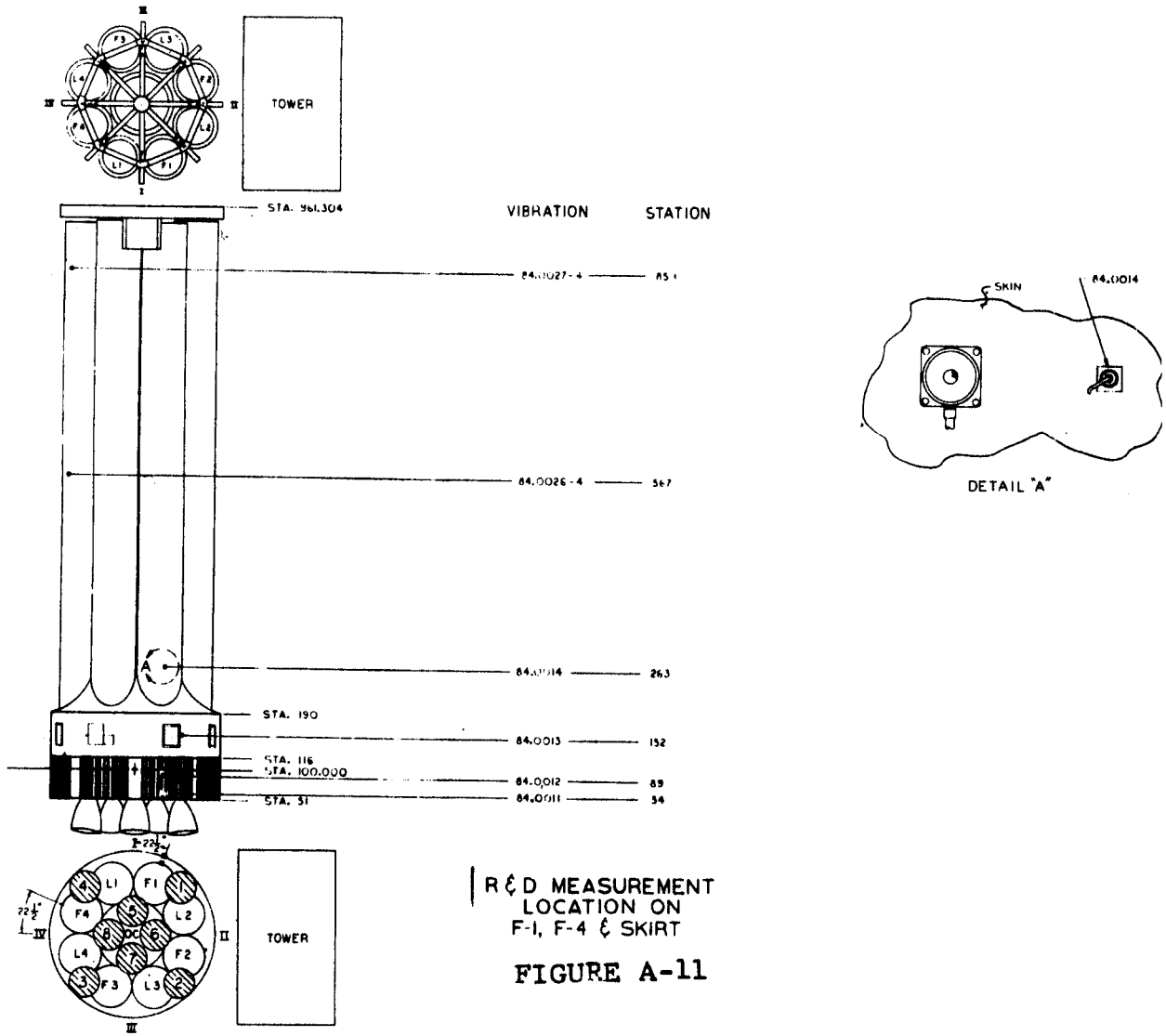
VIEW B-B
ROTATED 180°



VIEW C-C

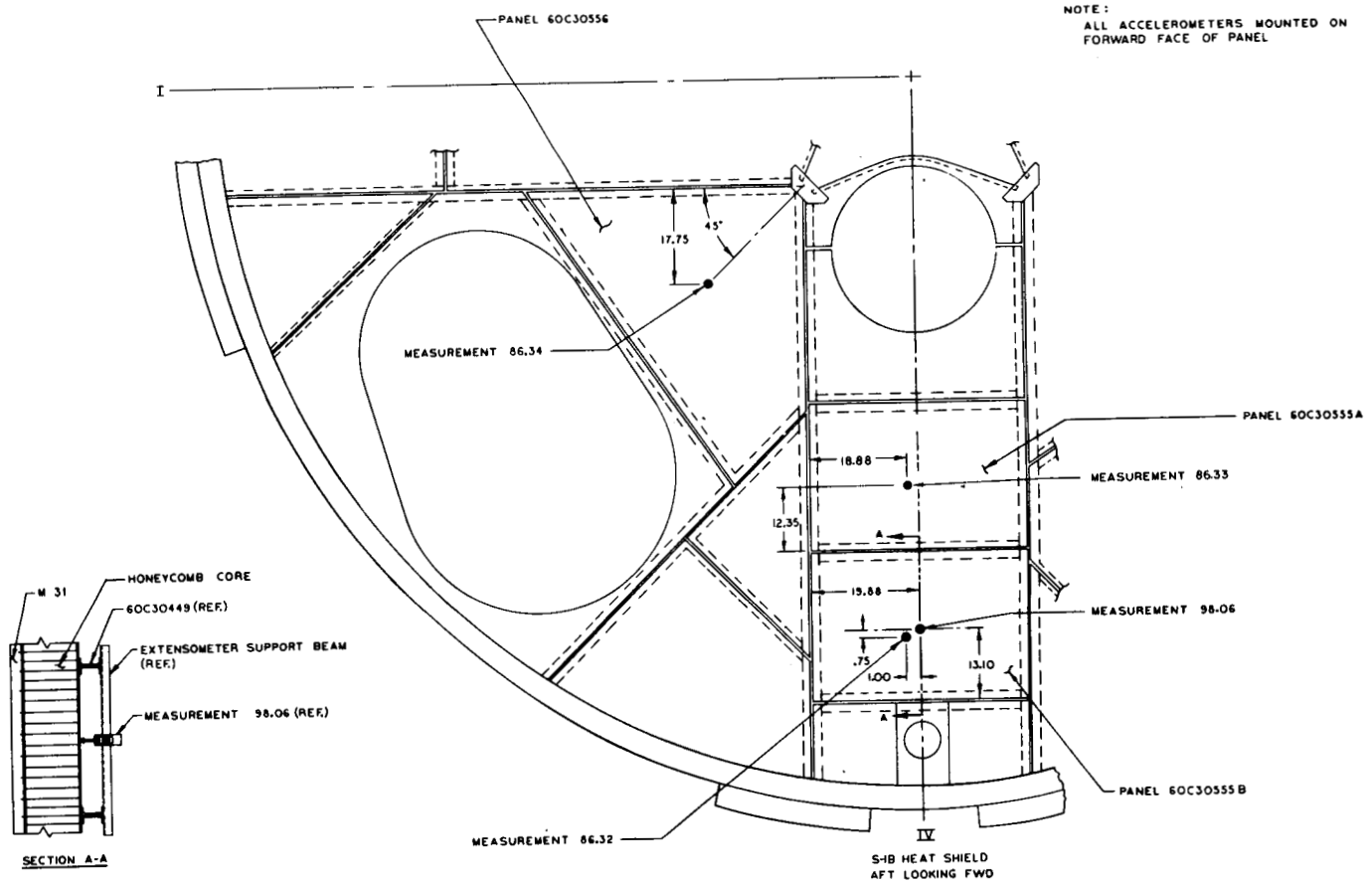
R & D MEASUREMENT
LOCATION ON
BOTTOM OF FUEL TANKS

FIGURE A-10



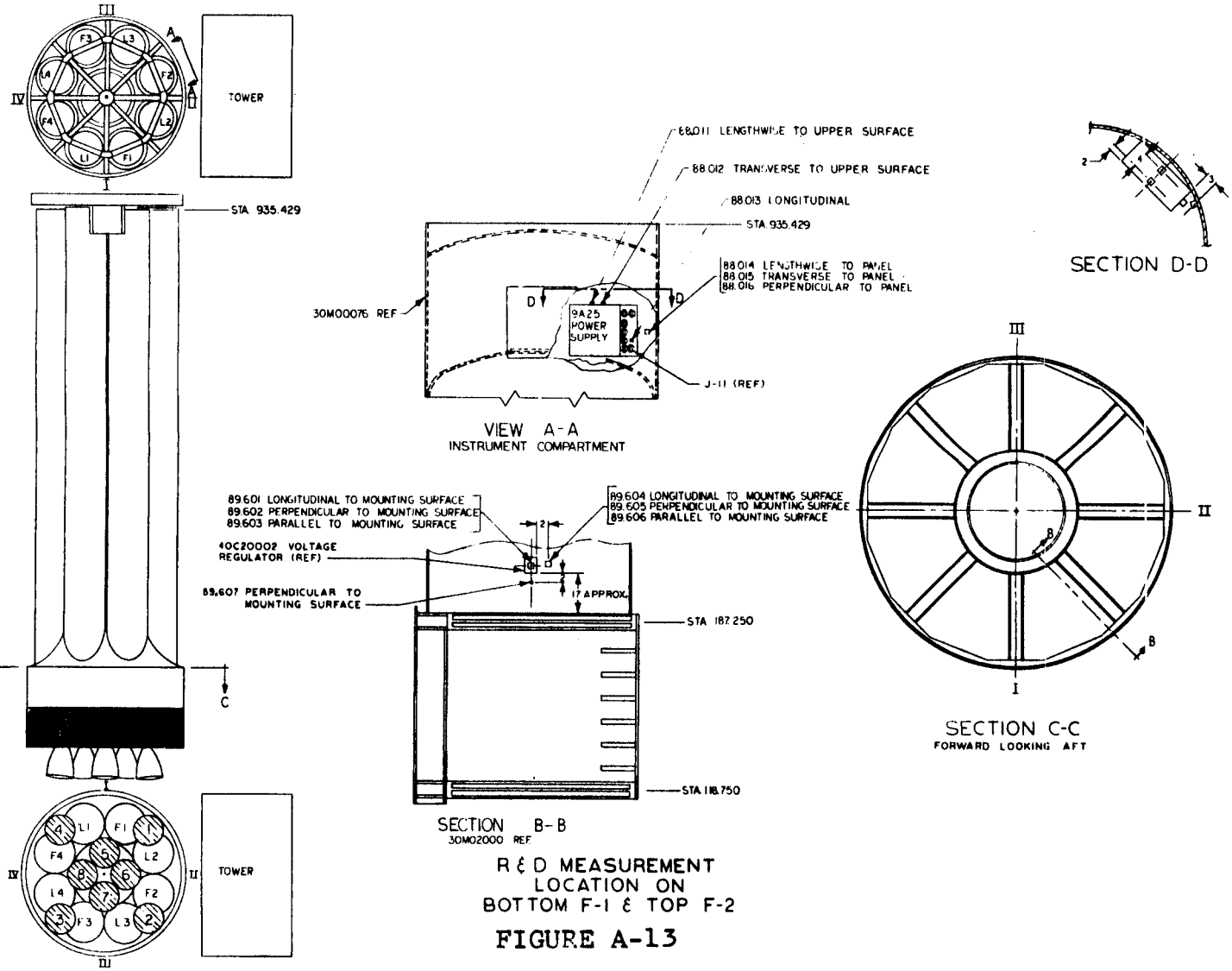
R & D MEASUREMENT LOCATION ON F-1, F-4 & SKIRT

FIGURE A-11



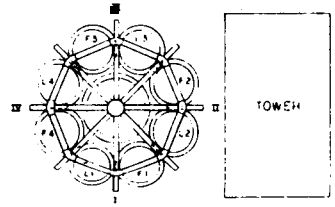
R & D MEASUREMENT
S-IB HEAT SHIELD PANELS

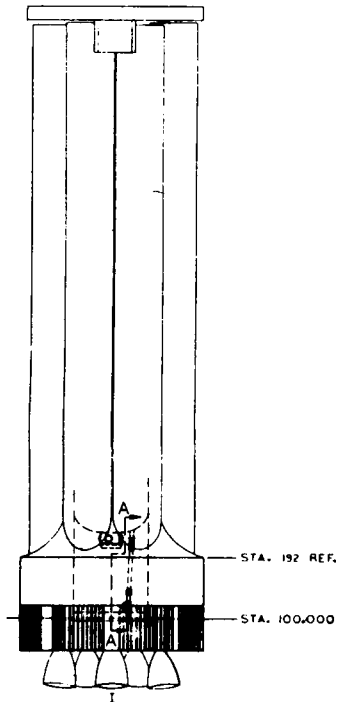
FIGURE A-12

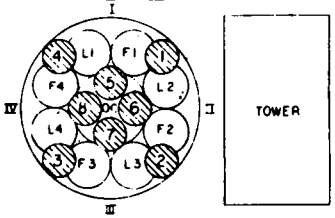


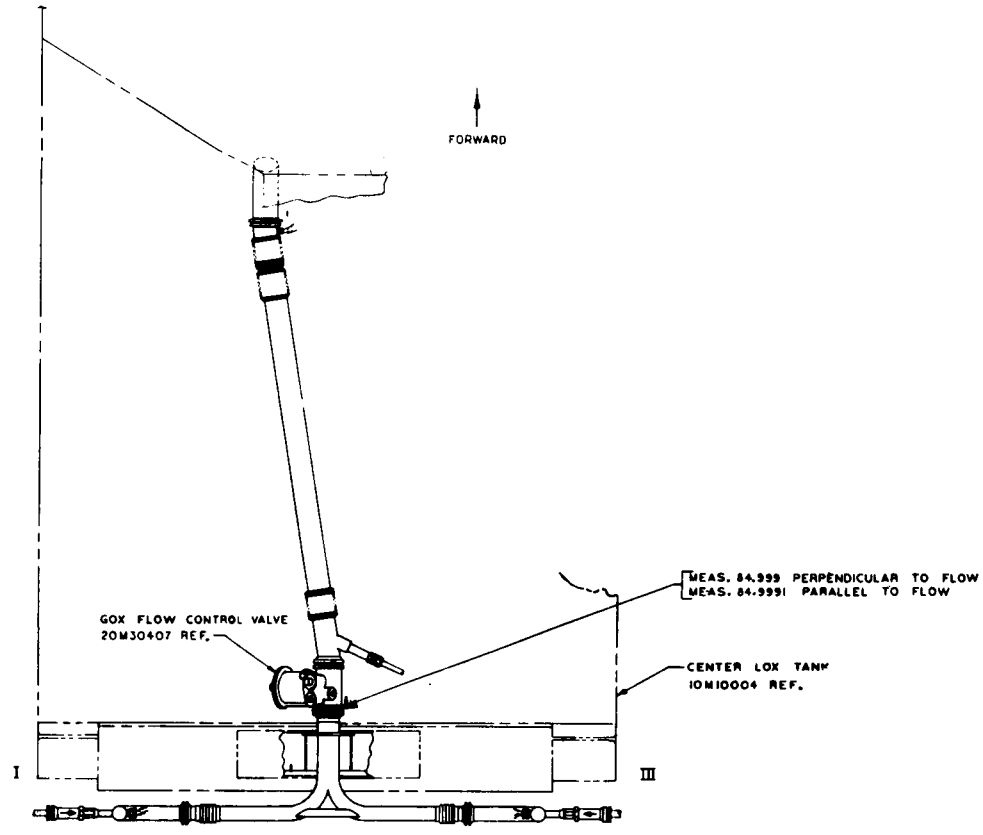
R & D MEASUREMENT
LOCATION ON
BOTTOM F-1 & TOP F-2

FIGURE A-13









SECTION A-A
CENTER LOX TANK & GOX SYS.

R & D MEASUREMENT
LOCATION ON
GOX LINE

FIGURE A-14

APPENDIX B

DEFINITIONS AND REDUCED DATA

Definitions

Telemetered Measurements

1. Vibration ----------Figures B-1 through B-23
2. Acoustic ---------- Figures B-24

Hardwire Measurements

1. Vibration ---------- Figures B-25 through B-107

DEFINITIONS

1.	Gaussian Amplitude Probability Distribution	A curve obtained by plotting the number of occurrences of a certain amplitude versus the probability. The Gaussian, or "normal" curve, has a bell-shape appearance with the highest probability near the mean value.
2.	Mean	A measure of the location of amplitudes in a distribution. The mean is found by summing the values of the individual amplitudes in the distribution and dividing by their number. The mean of a Gaussian distribution is equal to the median value. For structural vibration, the mean value is zero.
3.	Standard Deviation	The root-mean-square value of the amplitude in a distribution. As used in this report, standard deviation is equal to the composite G_{rms} level for a given time slice.
4.	Kurtosis	A statistical property of an amplitude distribution which is a measure of the width of the peak of the bell shape curve at the mean value and a measure of the width of the mouth of the curve. A kurtosis coefficient equal to three is associated with a Gaussian or "normal distribution."
5.	Skewness	A property of a distribution which is a measure of the deviation of the curve from the mean value. In a symmetrical distribution (Gaussian distribution) the mean and median are equal and the skewness coefficient tends to zero.

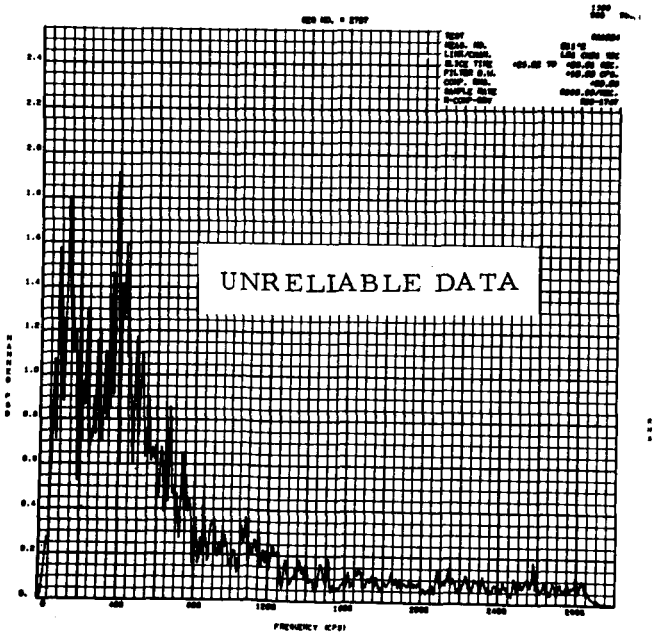
DEFINITIONS (continued)

6. Chi-Square	A statistical parameter obtained by summing the squares of (k) independent random variables (statistical degrees of freedom). Chi-square ranges from zero to infinity and is a measure of the degree of correlation between the given amplitude distribution and a Gaussian distribution.

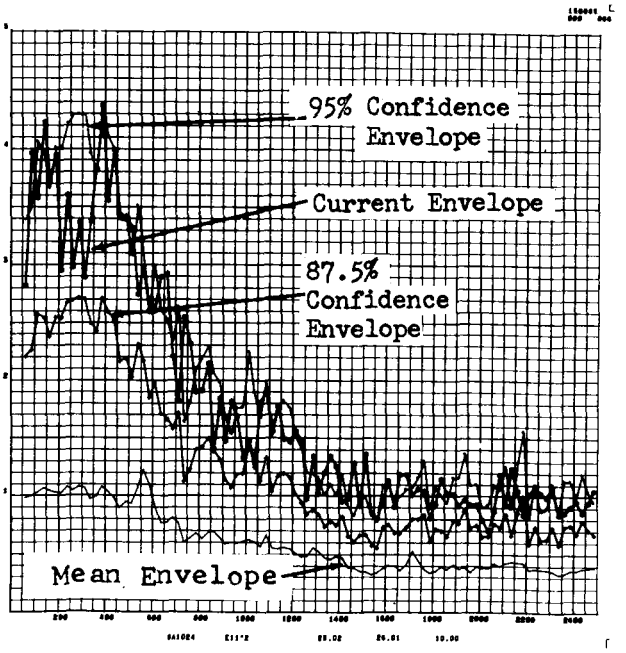
Meas. No.:	E11-2	Mean:	0.046
Description:	Thrust Chamber Dome	S.D.:	30.08
Run No:	SA1024	Skewness:	0.019
Slice Time:	25-26	Kurtosis:	3.18
Calib. Range:	±50 G	Chi-Square:	43.28
Zone:	1-2	2.5%:	28.85
		5%:	26.30

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
60	4.09	135	2.61
90	3.32	220	2.43
35	3.09	20	2.33
110	2.64	265	2.25
185	2.61	570	2.15



PSD vs. FREQ.



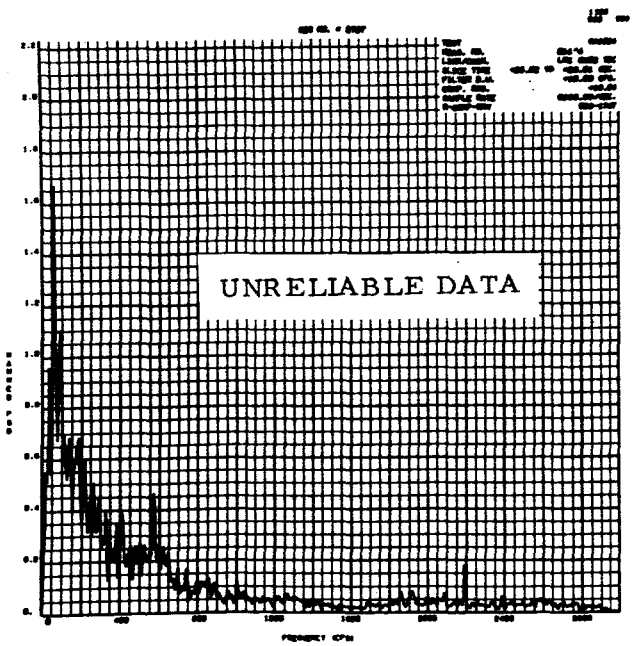
G_{RMS} vs. FREQ.

FIGURE B-1

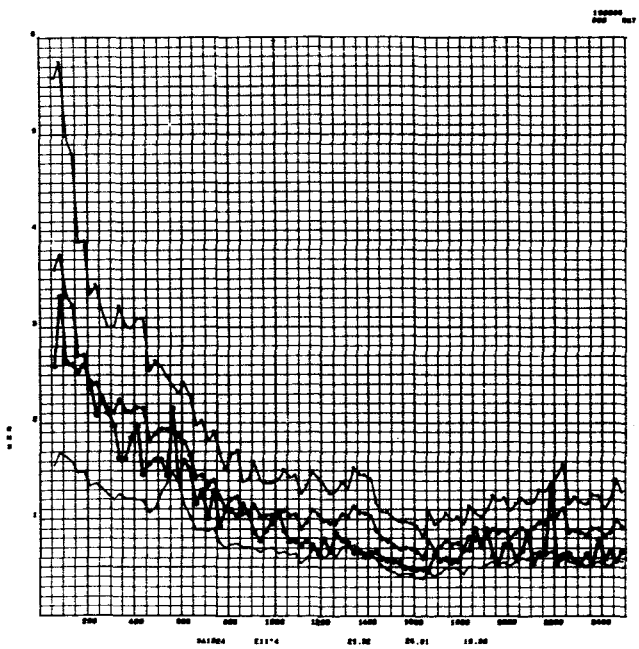
Meas. No.:	E11-4	Mean:	0.16
Description:	Thrust Chamber Dome	S.D.:	19.04
Run No:	SA1024	Skewness:	-0.02
Slice Time:	25-26	Kurtosis:	3.91
Calib. Range:	+50 G	Chi-Square:	81.76
Zone:	1-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
60	4.09	135	2.61
90	3.32	220	2.43
35	3.09	20	2.33
110	2.64	265	2.25
185	2.61	570	2.15



PSD vs. FREQ.



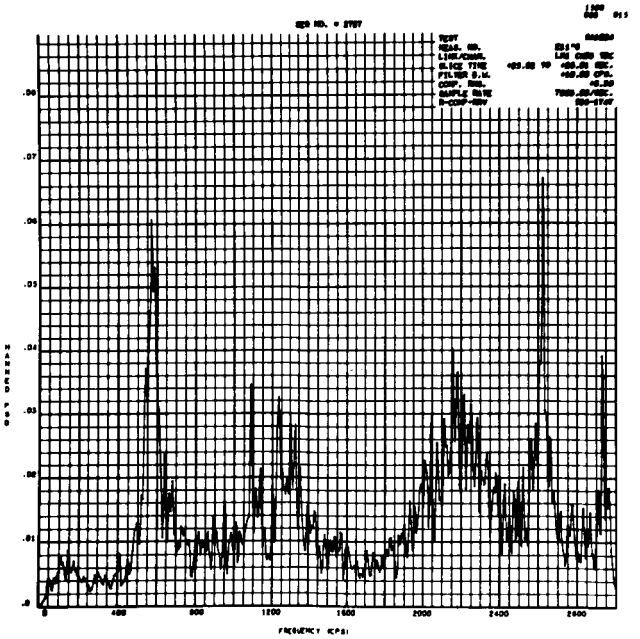
G_{RMS} vs. FREQ.

FIGURE B-2

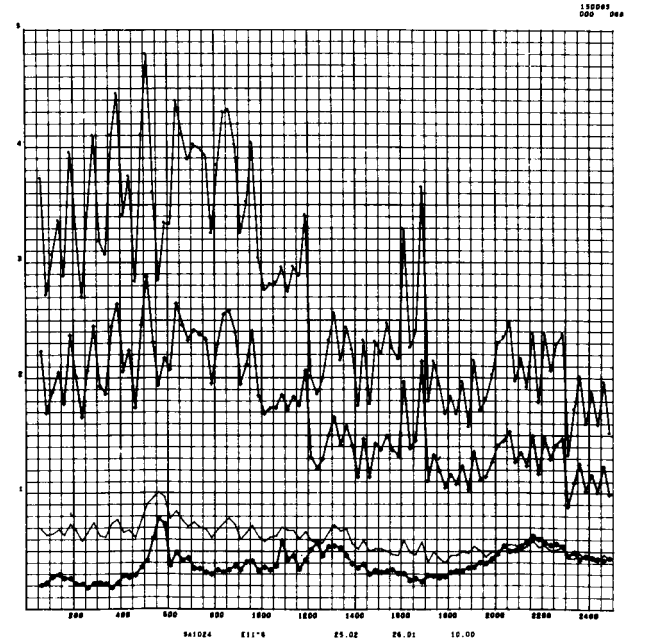
Meas. No.:	E11-6	Mean:	-0.018
Description:	Thrust Chamber Dome	S.D.:	6.38
Run No:	SA1024	Skewness:	-0.030
Slice Time:	25-26	Kurtosis:	3.05
Calib. Range:	+50 G	Chi-Square:	19.30
Zone:	I-2	2.5%:	26.12
		5%:	23.68

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
2626	0.82	2611	0.62
570	0.78	540	0.61
585	0.73	2181	0.60
2156	0.63	1085	0.59
2931	0.63	2216	0.58



PSD vs. FREQ.



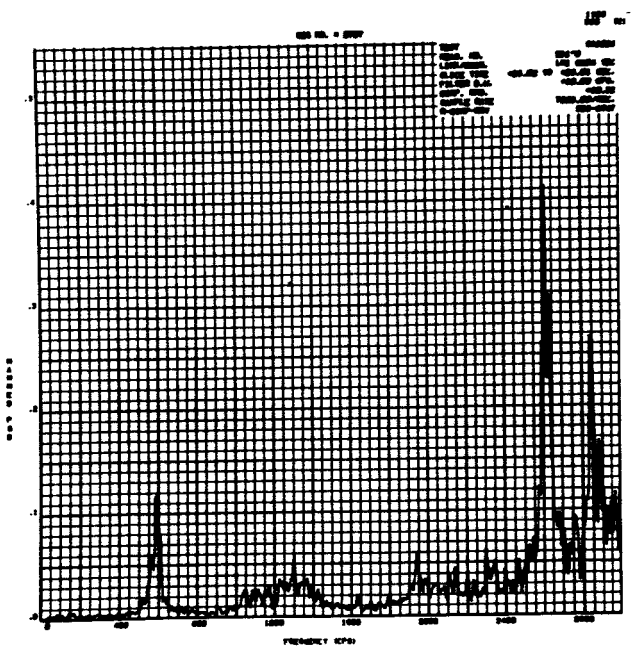
GRMS vs. FREQ.

FIGURE B-3

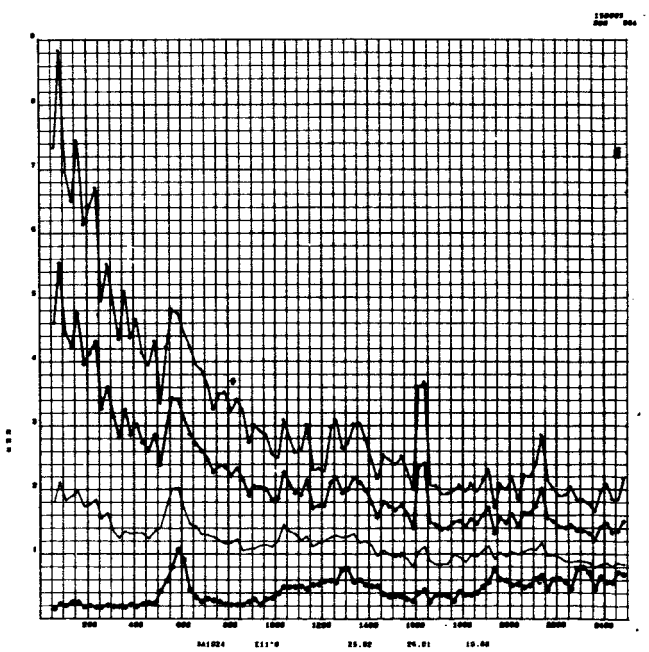
Meas. No.:	E11-8	Mean:	-0.042
Description:	Thrust Chamber Dome	S.D.:	10.32
Run No:	SA1024	Skewness:	0.0028
Slice Time:	25-26	Kurtosis:	3.04
Calib. Range:	±50 G	Chi-Square:	7.66
Zone:	1-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
2611	2.03	2881	1.29
2631	1.75	3011	1.15
2841	1.63	3001	1.14
2591	1.62	2571	1.10
3036	1.43	585	1.08



PSD vs. FREQ.



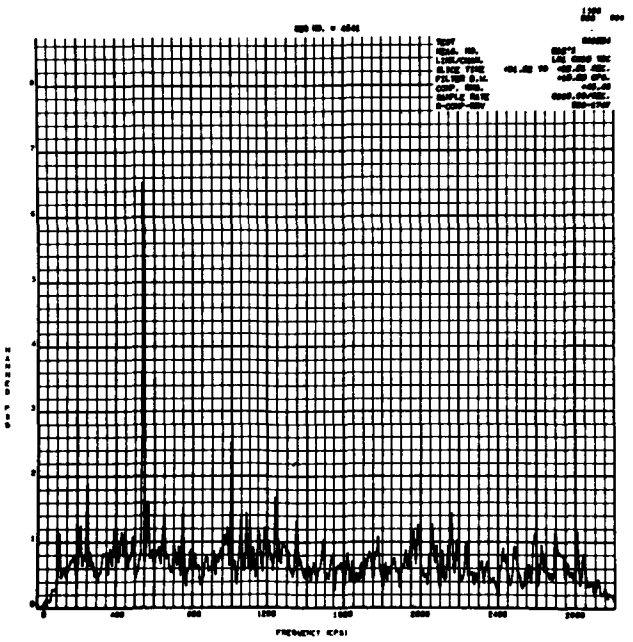
G_{RMS} vs. FREQ.

FIGURE B-4

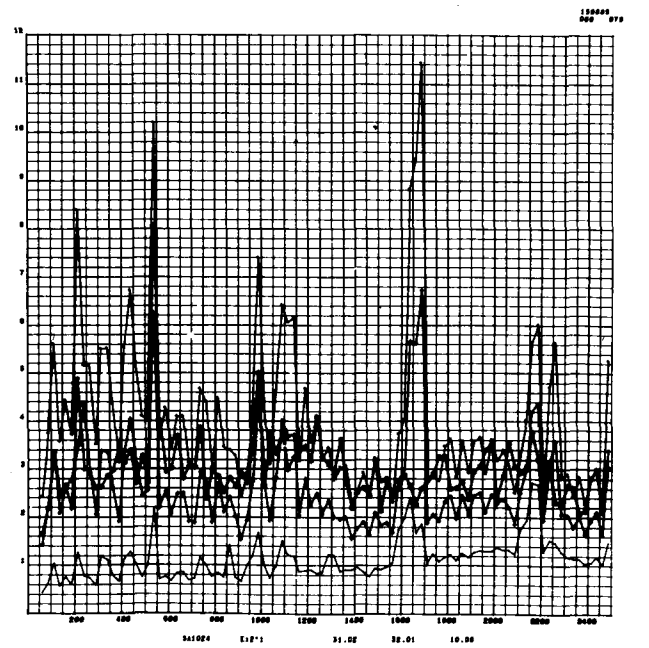
Meas. No.:	E12-1	Mean:	-0.000002
Description:	Turbine Gear Box	S.D.:	45.45
Run No:	SA1024	Skewness:	0.063
Slice Time:	31-32	Kurtosis:	2.67
Calib. Range:	±50 G	Chi-Square:	56.11
Zone:	1-1	2.5%:	28.85
		5%:	26.30

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
540	8.08	745	3.87
995	5.01	2165	3.78
250	4.34	1080	3.78
1240	4.09	1050	3.71
565	4.01	645	3.69



PSD vs. FREQ.



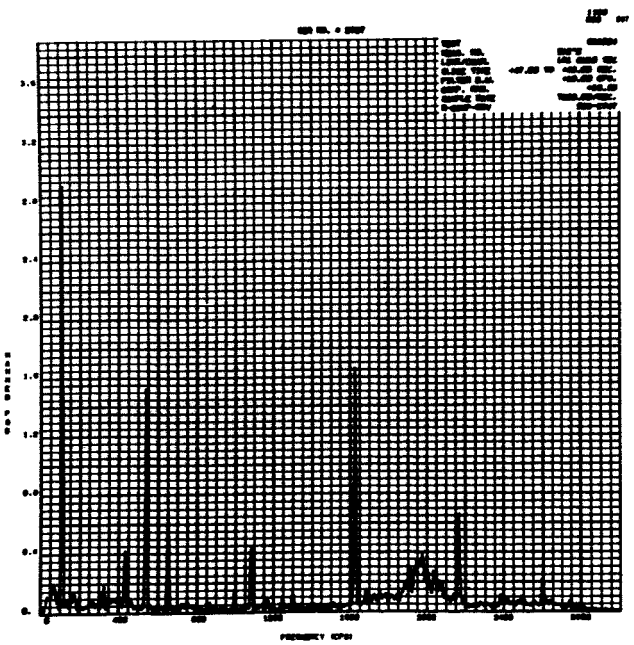
G_{RMS} vs. FREQ.

FIGURE B-5

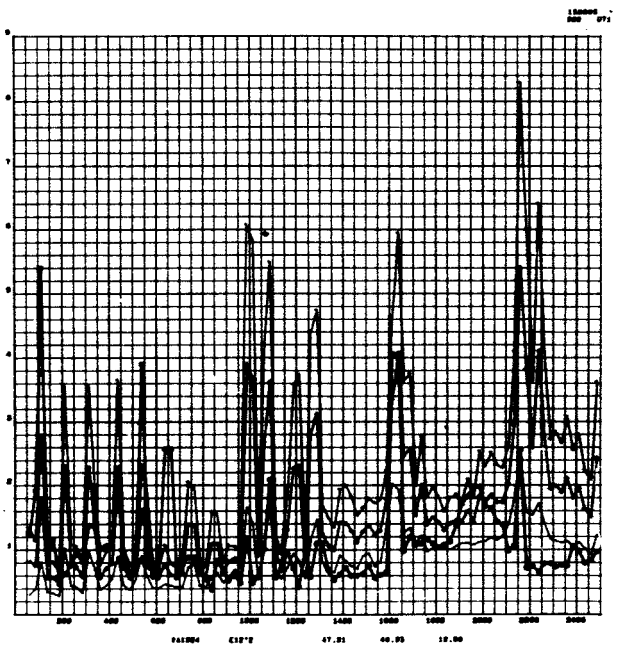
Meas. No.:	E12-2	Mean:	0.10
Description:	Turbine Gear Box	S.D.:	16.50
Run No:	SA1024	Skewness:	-0.019
Slice Time:	47-48	Kurtosis:	2.94
Calib. Range:	+50 G	Chi-Square:	8.53
Zone:	T-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
110	5.41	1085	2.10
1625	4.07	435	2.04
540	3.91	1975	1.99
650	2.58	1945	1.84
2165	2.56	1960	1.83



PSD vs. FREQ.



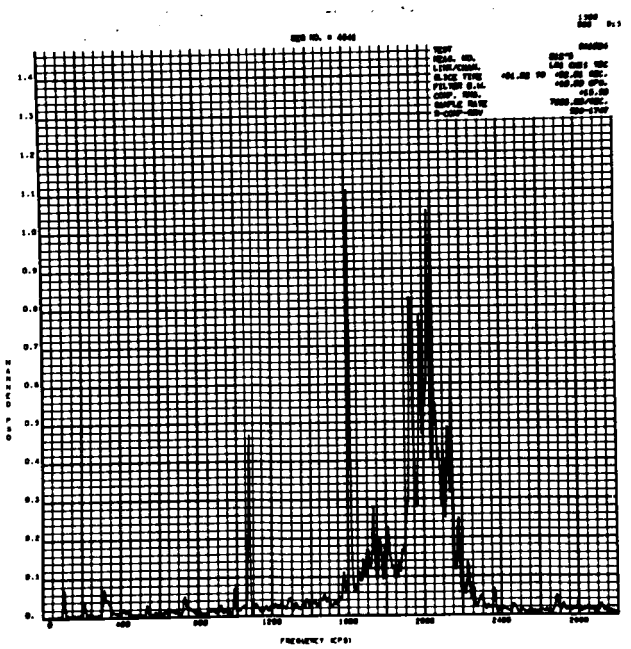
GRMS vs. FREQ.

FIGURE B-6

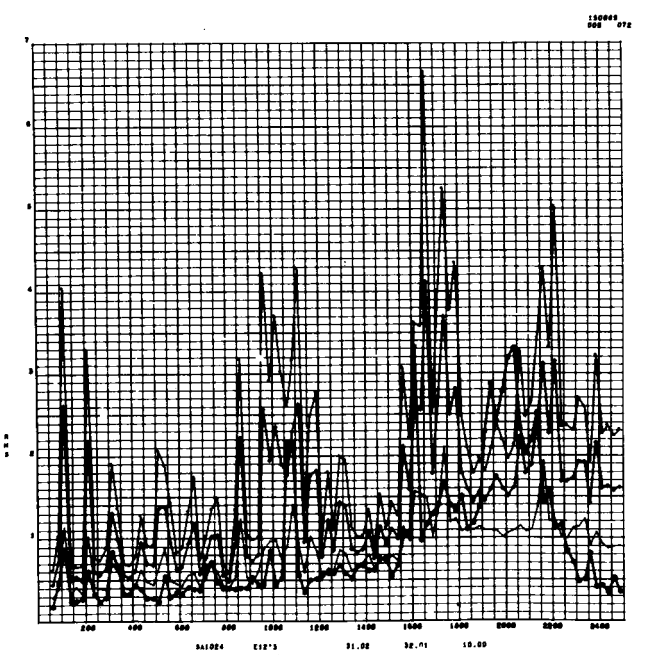
Meas. No.:	E12-3	Mean:	0.19
Description:	Turbine Gear Box	S.D.:	15.50
Run No:	SA1024	Skewness:	0.020
Slice Time:	31-32	Kurtosis:	3.11
Calib. Range:	+50 G	Chi-Square:	13.26
Zone:	1-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
1610	3.33	2145	2.52
2045	3.31	2000	2.36
2025	3.24	2060	2.34
1930	2.87	2125	2.20
1980	2.78	1075	2.16



PSD vs. FREQ.



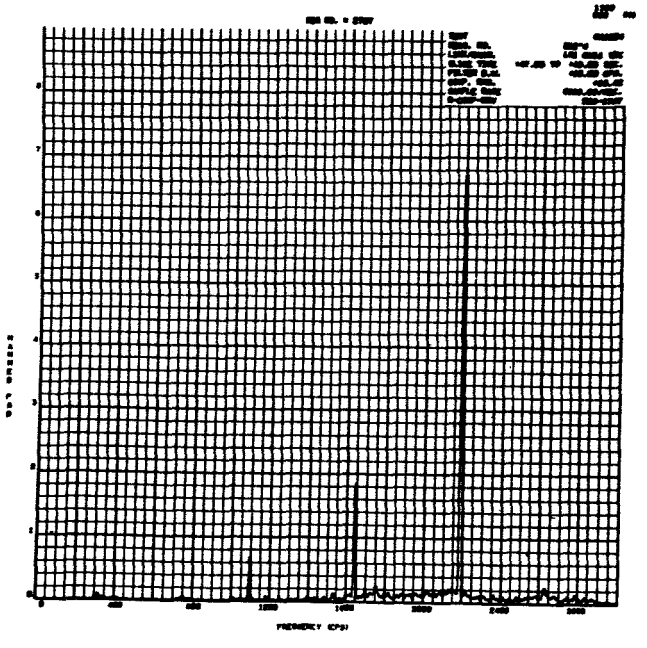
G_{RMS} vs. FREQ.

FIGURE B-7

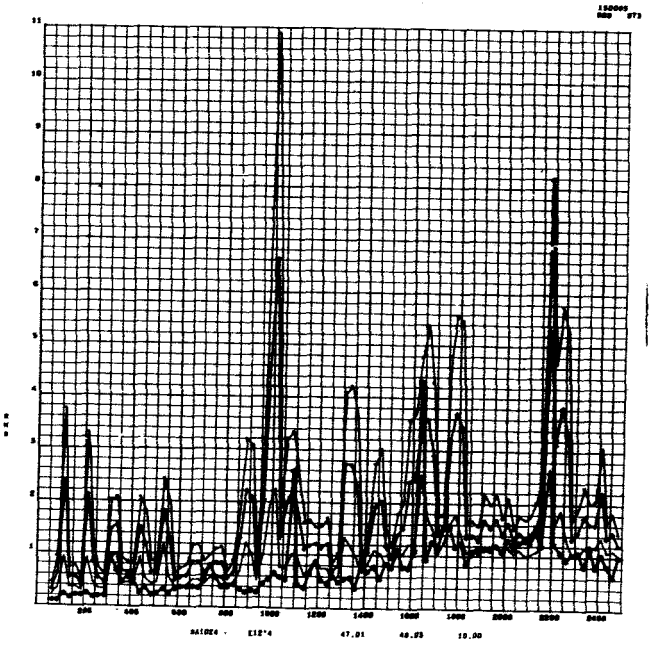
Meas. No.:	E12-4	Mean:	0.19
Description:	Turbine Gear Box	S.D.:	16.42
Run No:	SA1024	Skewness:	-0.0014
Slice Time:	47-48	Kurtosis:	2.83
Calib. Range:	±50 G	Chi-Square:	28.84
Zone:	1-1	2.5%:	31.63
		5%:	28.87

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
2190	8.20	2135	1.47
1645	4.31	2150	1.37
1095	2.60	2160	1.35
2630	1.57	2110	1.32
1755	1.57	2020	1.31



PSD vs. FREQ.



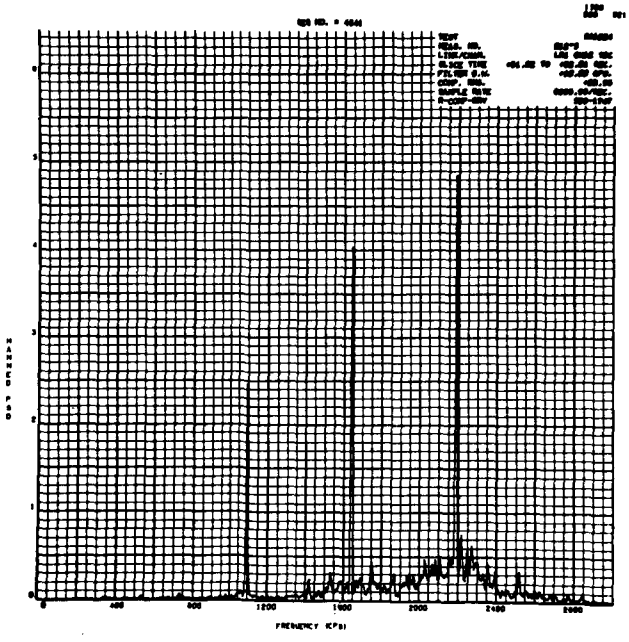
G_{RMS} vs. FREQ.

FIGURE B-8

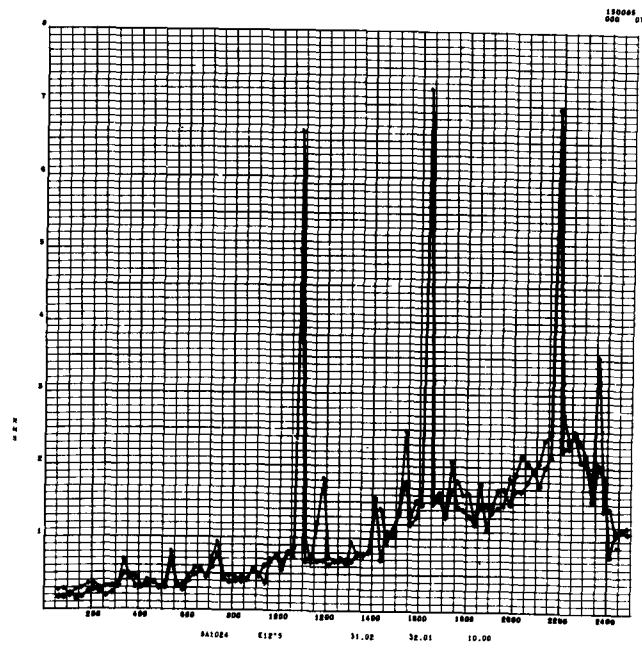
Meas. No.:	E12-5	Mean:	0.16
Description:	Turbine Gear Box	S.D.:	20.57
Run No:	SA1024	Skewness:	0.013
Slice Time:	31-32	Kurtosis:	2.86
Calib. Range:	± 50 G	Chi-Square:	16.02
Zone:	1-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
2189	6.97	2249	2.35
1640	6.35	2104	2.26
1095	4.96	2159	2.21
2219	2.74	2029	2.16
2274	2.50	2084	2.16



PSD vs. FREQ.



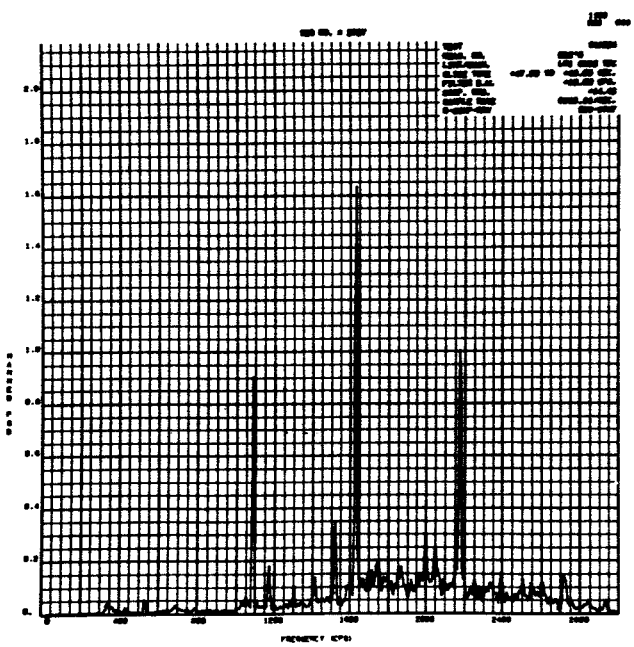
G_{RMS} vs. FREQ.

FIGURE B-9

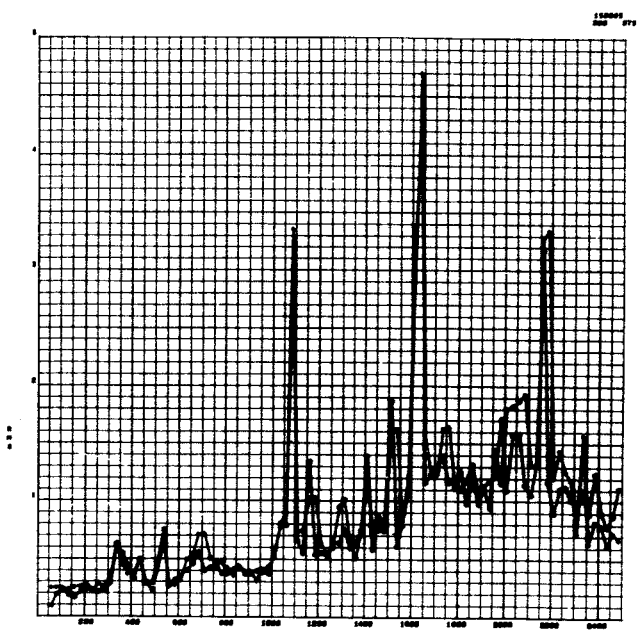
Meas. No.:	E12-6	Mean:	0.16
Description:	Turbine Gear Box	S.D.:	14.42
Run No:	SA1024	Skewness:	0.0089
Slice Time:	47-48	Kurtosis:	2.71
Calib. Range:	± 50 G	Chi-Square:	35.17
Zone:	1-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
1630	4.04	2050	1.58
2170	3.17	1745	1.39
1085	3.00	1170	1.34
1520	1.87	2150	1.34
1995	1.72	1865	1.23



PSD vs. FREQ.



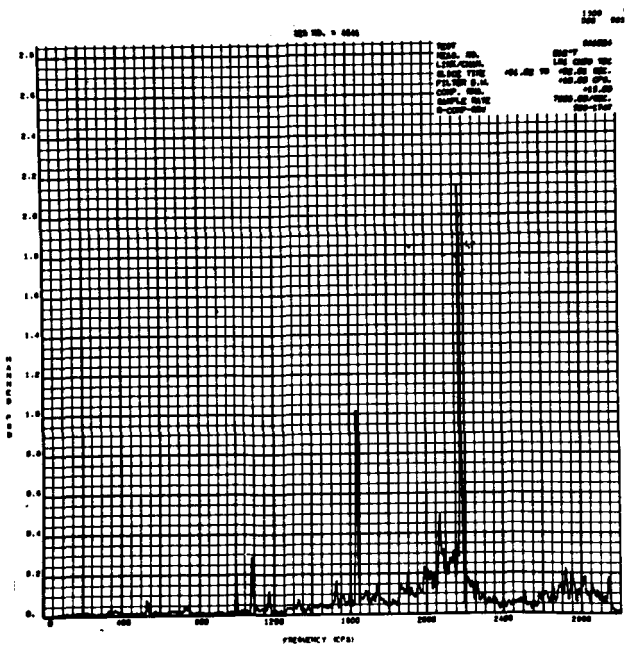
G_{RMS} vs. FREQ.

FIGURE B-10

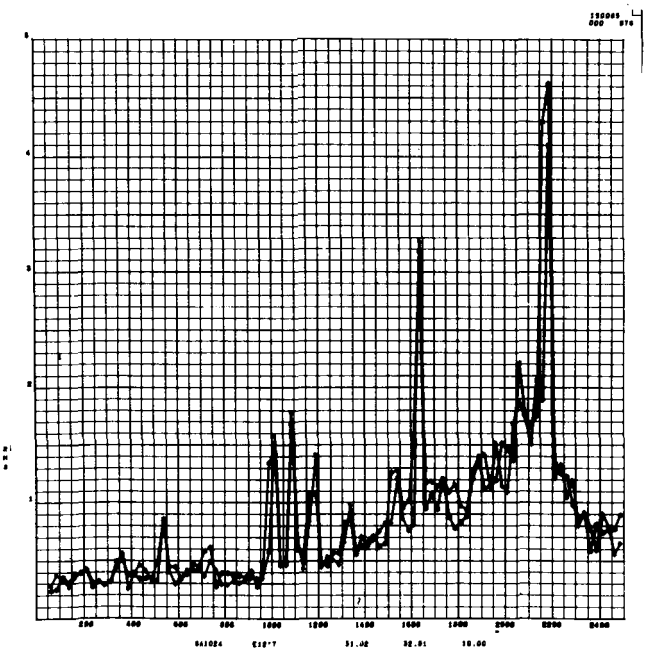
Meas. No.:	E 12-7	Mean:	0.015
Description:	Turbine Gear Box	S.D.:	15.00
Run No:	SA1024	Skewness:	0.054
Slice Time:	31-32	Kurtosis:	2.98
Calib. Range:	± 50 G	Chi-Square:	8.48
Zone:	1-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
2175	4.63	2140	1.76
1635	3.19	1090	1.69
2070	2.21	2120	1.65
2160	1.82	2100	1.59
2085	1.77	1985	1.52



PSD vs. FREQ.



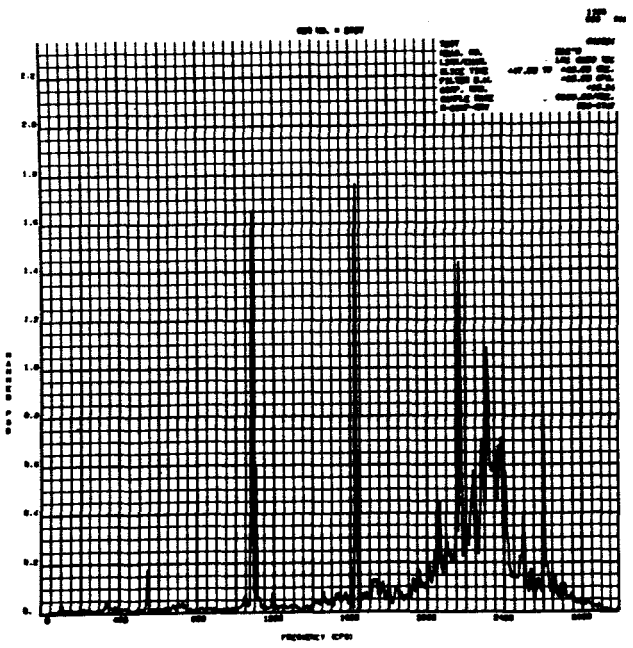
G_{RMS} vs. FREQ.

FIGURE B-11

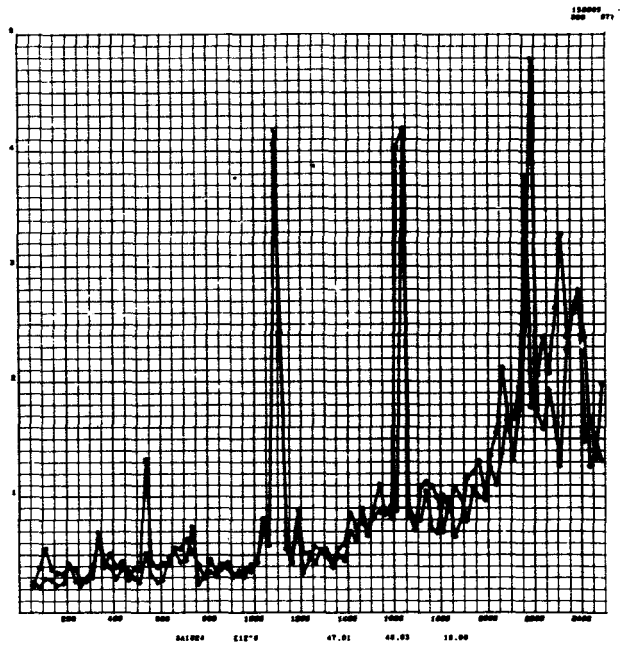
Meas. No.:	E 12-8	Mean:	0.026
Description:	Turbine Gear Box	S.D.:	18.34
Run No:	SA1024	Skewness:	0.028
Slice Time:	47-48	Kurtosis:	3.01
Calib. Range:	± 50 G	Chi-Square:	19.05
Zone:	1-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
1630	4.20	2385	2.66
1085	4.06	2285	2.65
2170	3.79	2375	2.60
2315	3.29	2355	2.55
2605	2.80	1105	2.43



PSD vs. FREQ.



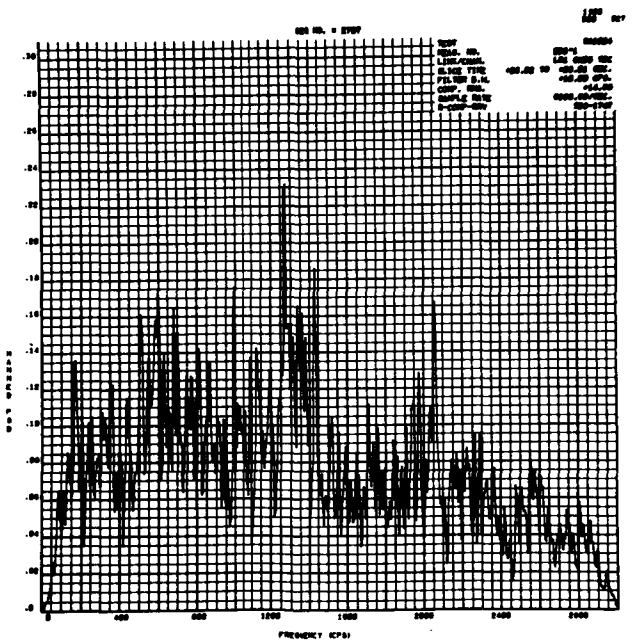
G_{RMS} vs. FREQ.

FIGURE B-12

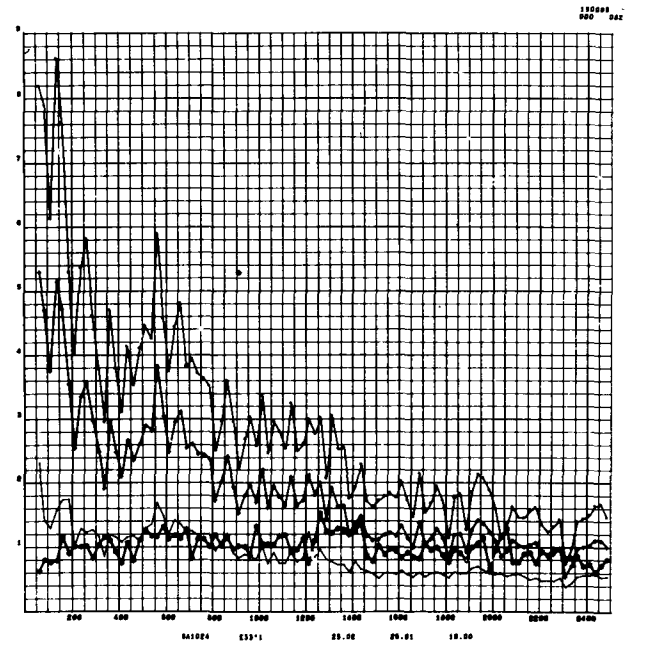
Meas. No.:	E33-1	Mean:	-0.18
Description:	Thrust Chamber Dome	S.D.:	14.98
Run No:	SA1024	Skewness:	0.14
Slice Time:	25-26	Kurtosis:	3.57
Calib. Range:	+50 G	Chi-Square:	135.37
Zone:	1-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
1274	1.52	1334	1.29
1429	1.36	670	1.28
994	1.33	1359	1.27
600	1.31	510	1.27
2059	1.29	585	1.26



PSD vs. FREQ.



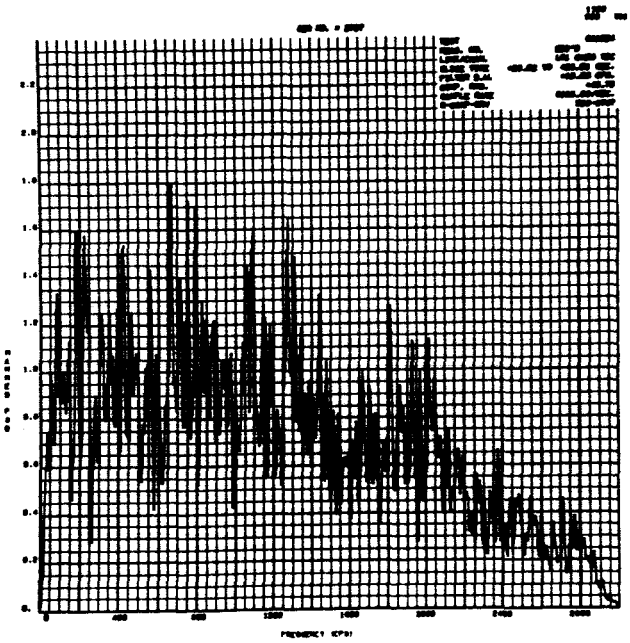
G_{RMS} vs. FREQ.

FIGURE B-13

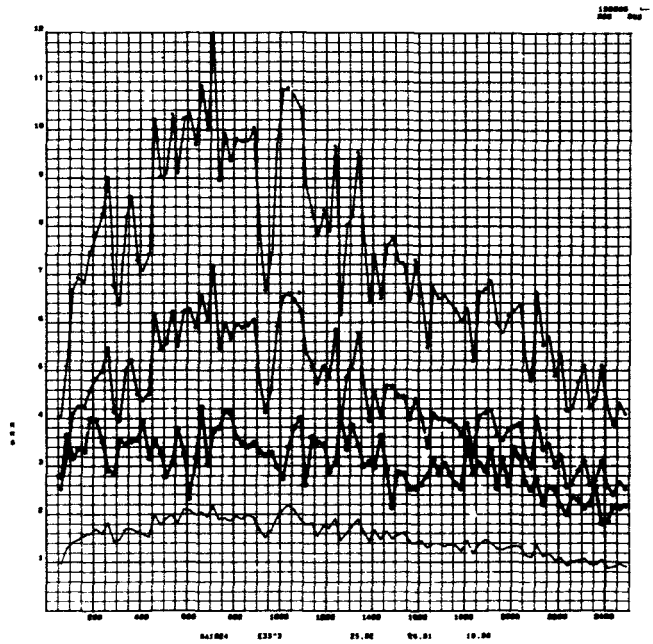
Meas. No.:	E33-3	Mean:	-0.17
Description:	Thrust Chamber Dome	S.D.:	45.73
Run No:	SA1024	Skewness:	0.17
Slice Time:	25-26	Kurtosis:	2.94
Calib. Range:	+50 G	Chi-Square:	64.92
Zone:	I-2	2.5%:	31.53
		5%:	28.87

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
665	4.24	180	4.00
755	4.15	225	3.98
790	4.11	425	3.92
1274	4.06	1314	3.85
1094	4.01	1064	3.80



PSD vs. FREQ.



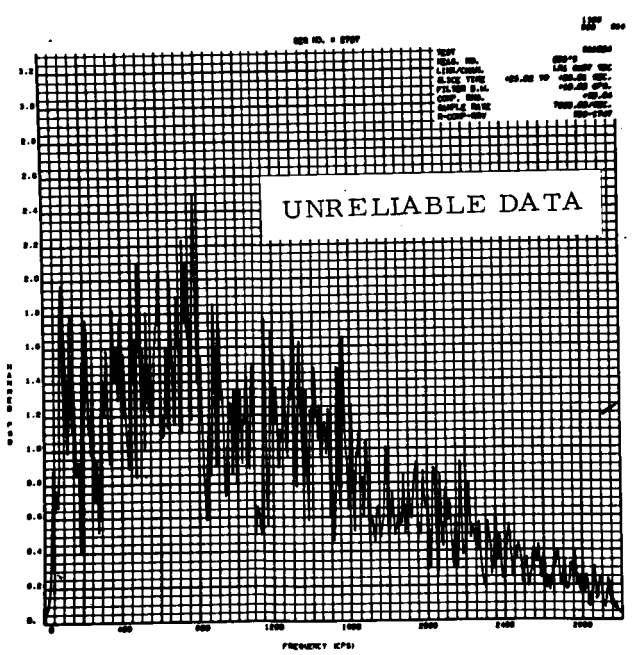
G_{RMS} vs. FREQ.

FIGURE B-14

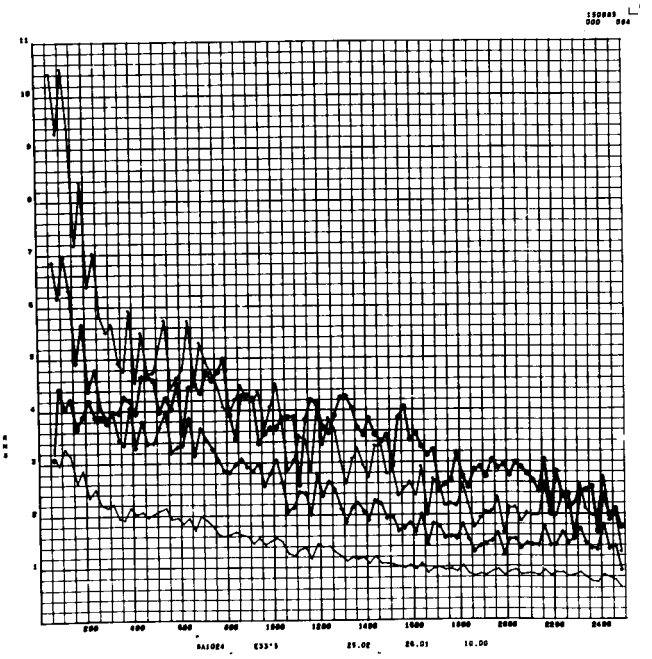
Meas. No.:	E33-5	Mean:	-0.037
Description:	Thrust Chamber Dome	S.D.:	50.64
Run No:	SA1024	Skewness:	-0.026
Slice Time:	25-26	Kurtosis:	2.93
Calib. Range:	±50 G	Chi-Square:	38.88
Zone:	1-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
780	4.99	595	4.51
720	4.72	650	4.50
450	4.68	90	4.44
485	4.58	685	4.35
735	4.58	875	4.30



PSD vs. FREQ.



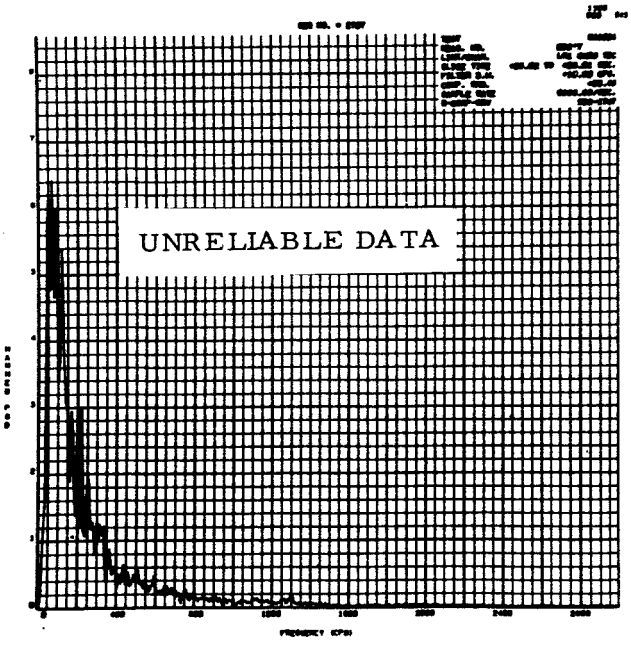
GRMS vs. FREQ.

FIGURE B-15

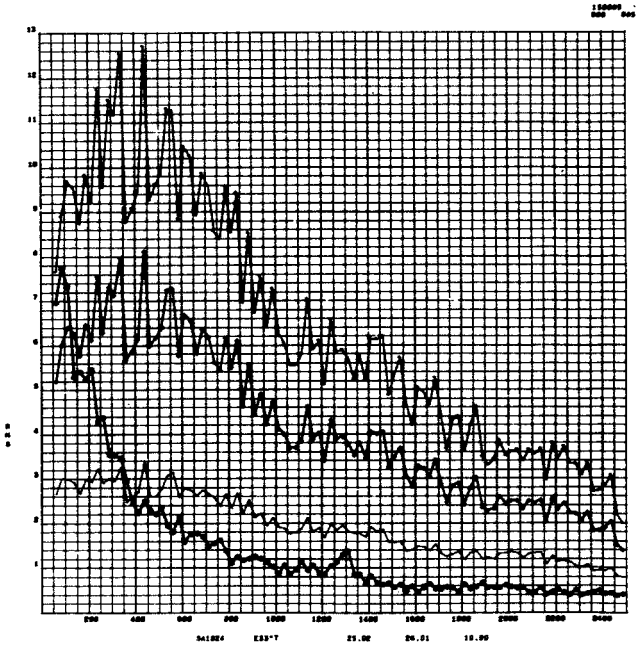
Meas. No.:	E33-7	Mean:	0.13
Description:	Thrust Chamber Dome	S.D.:	33.45
Run No:	SA1024	Skewness:	0.095
Slice Time:	25-26	Kurtosis:	3.00
Calib. Range:	±50 G	Chi-Square:	35.03
Zone:	1-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
70	8.01	170	5.42
50	7.83	200	5.24
90	7.75	255	4.39
120	7.34	275	3.57
220	5.48	300	3.55



PSD vs. FREQ.



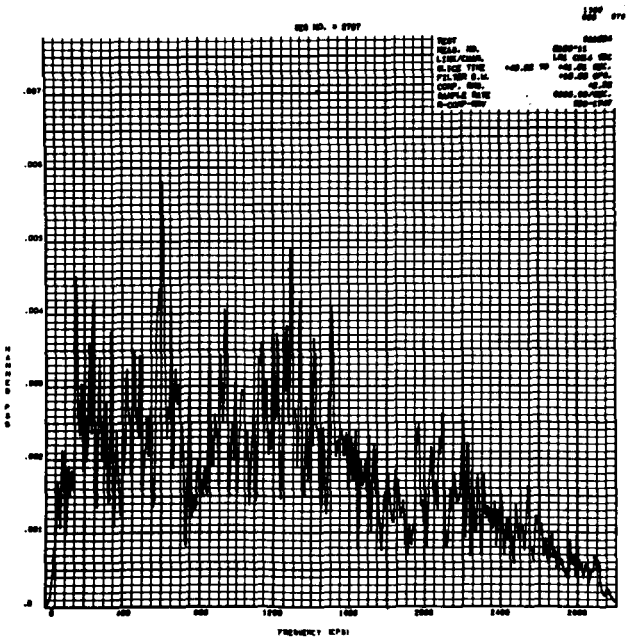
G_{RMS} vs. FREQ.

FIGURE B-16

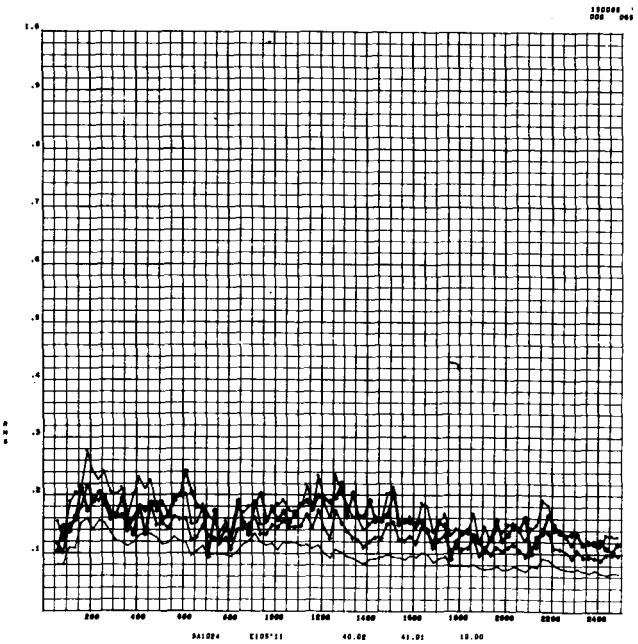
Meas. No.:	E 105-11	Mean:	0.0037
Description:	Spider Beam	S.D.:	2.32
Run No:	SA1024	Skewness:	0.0037
Slice Time:	40-41	Kurtosis:	3.06
Calib. Range:	± 25 G	Chi-Square:	14.52
Zone:	7-2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
610	0.24	1340	0.20
1290	0.22	650	0.20
160	0.21	1510	0.20
590	0.21	580	0.20
245	0.20	935	0.20



PSD vs. FREQ.



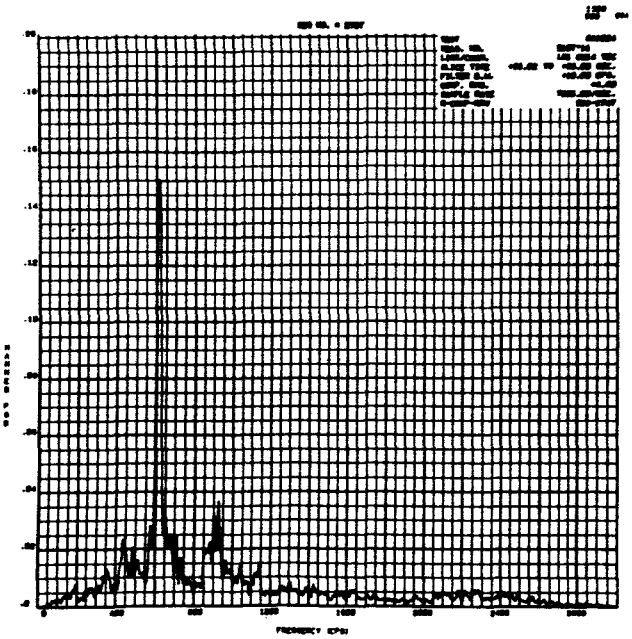
G_{RMS} vs. FREQ.

FIGURE B-17

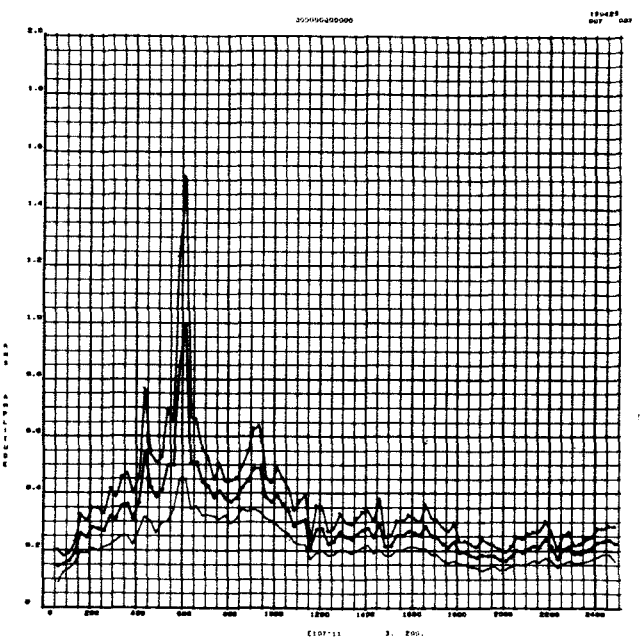
Meas. No.:	E107-11	Mean:	0.081
Description:	Spider Beam	S.D.:	4.60
Run No:	SA10 24	Skewness:	-0.019
Slice Time:	55-56	Kurtosis:	2.95
Calib. Range:	± 25 G	Chi-Square:	13.42
Zone:	7-2	2.5%:	31.53
		5%:	28.87

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
615	1.23	675	0.50
925	0.60	710	0.49
905	0.56	440	0.48
650	0.55	885	0.47
575	0.53	485	0.45



PSD vs. FREQ.



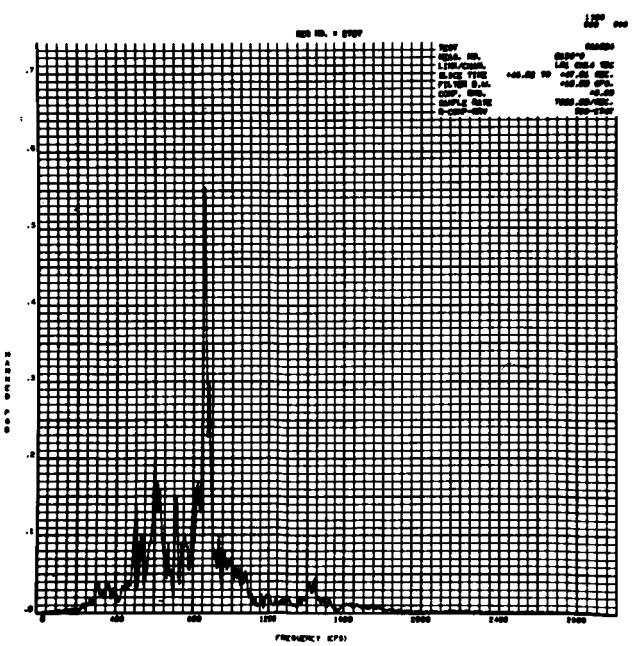
G_{RMS} vs. FREQ.

FIGURE B-18

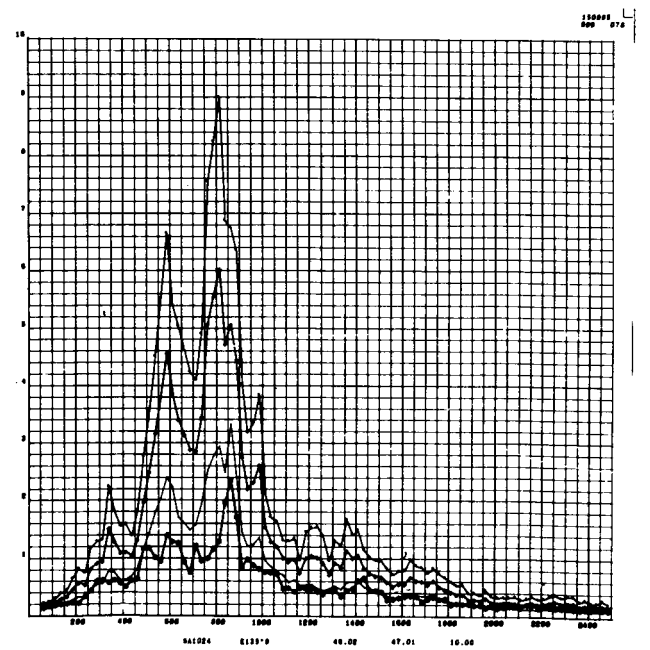
Meas. No.:	E 135-9	Mean:	0.18
Description:	Shear Beam	S.D.:	8.98
Run No:	SA1024	Skewness:	-0.0098
Slice Time:	46-47	Kurtosis:	2.89
Calib. Range:	± 30 G	Chi-Square:	19.75
Zone:	2-3	2.5%:	27.49
		5%:	25.00

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
860	2.35	625	1.26
880	1.72	710	1.22
595	1.40	500	1.17
820	1.29	795	1.16
610	1.28	530	1.00



PSD vs. FREQ.



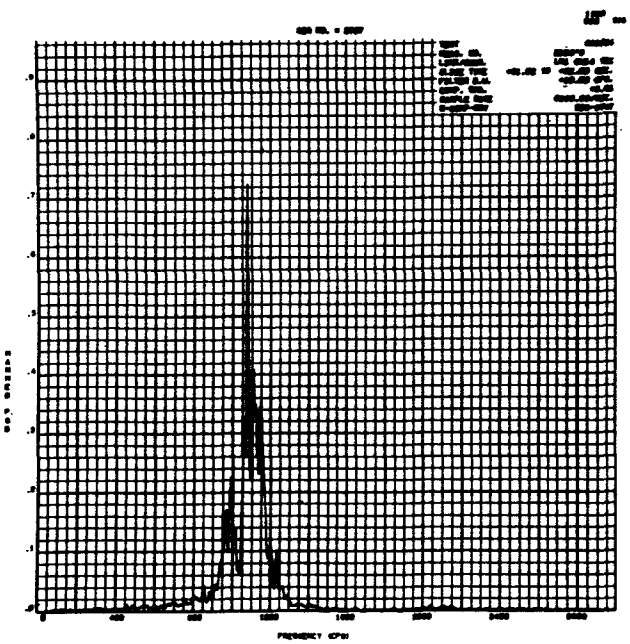
G_{RMS} vs. FREQ.

FIGURE B-19

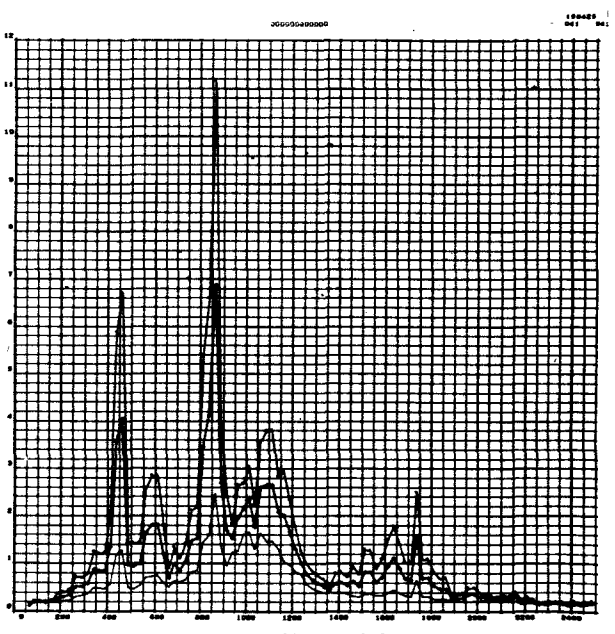
Meas. No.:	E 136-9	Mean:	0.085
Description:	Shear Beam	S. D.:	8.63
Run No:	SA1024	Skewness:	-0.012
Slice Time:	61-62	Kurtosis:	2.83
Calib. Range:	± 30 G	Chi-Square:	18.97
Zone:	2-3	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
1075	2.69	1095	1.64
1110	2.02	990	1.50
1150	1.88	965	1.30
1120	1.87	1015	1.18
1060	1.80	1205	1.04



PSD vs. FREQ.



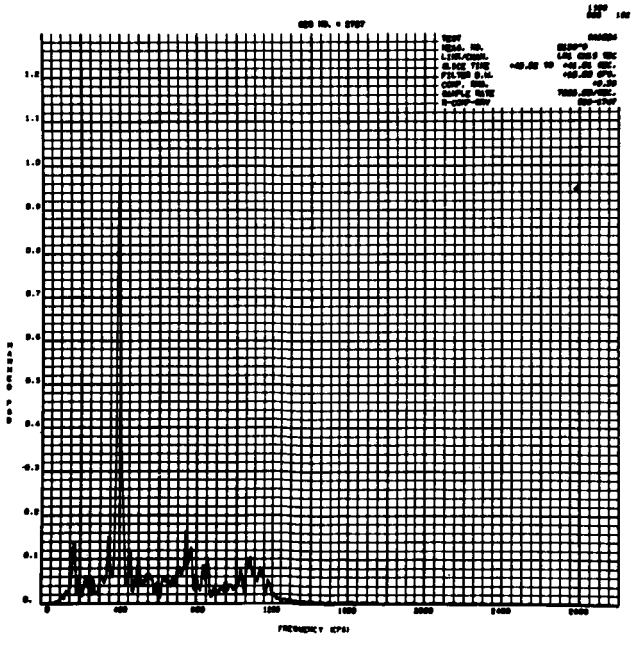
G_{RMS} vs. FREQ.

FIGURE B-20

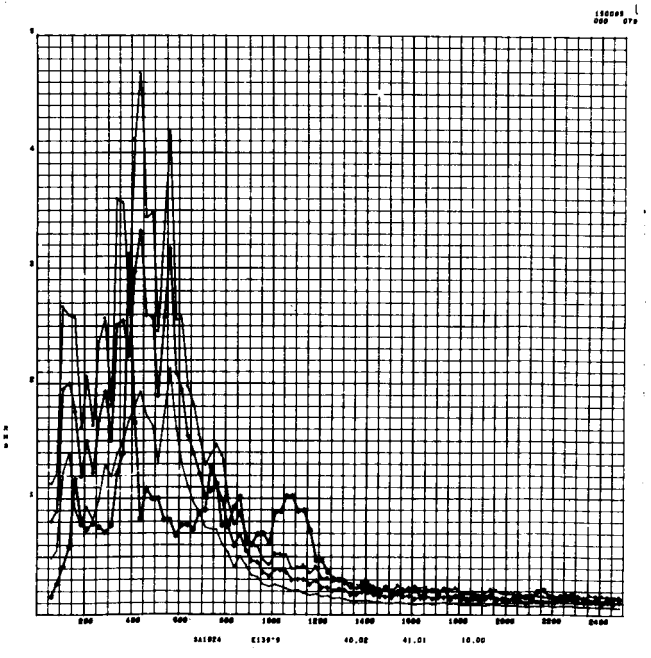
Meas. No.:	E139-9	Mean:	-0.0070
Description:	Shear Beam Top	S.D.:	9.39
Run No:	SA1024	Skewness:	-0.012
Slice Time:	40-41	Kurtosis:	3.06
Calib. Range:	± 30 G	Chi-Square:	11.81
Zone:	2-3	2.5%:	28.85
		5%:	26.30

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
395	3.12	770	1.13
415	1.66	460	1.09
740	1.28	1075	1.02
340	1.22	855	1.01
170	1.16	500	1.00



PSD vs. FREQ.



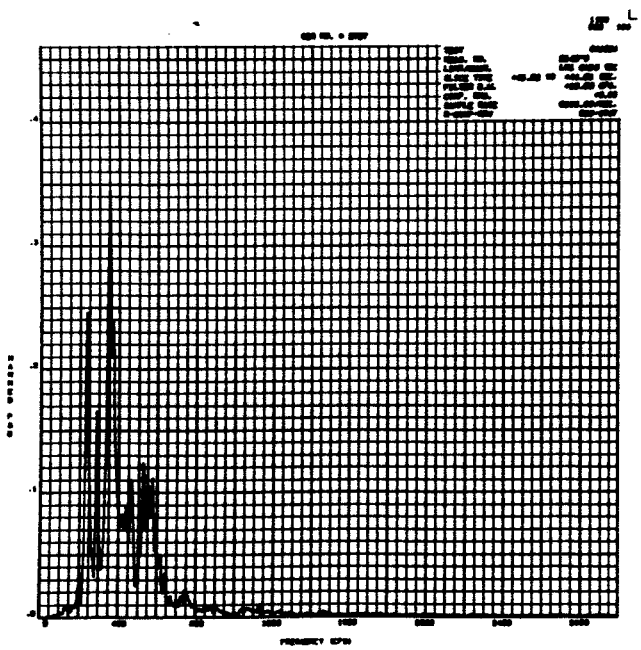
G_{RMS} vs. FREQ.

FIGURE B-21

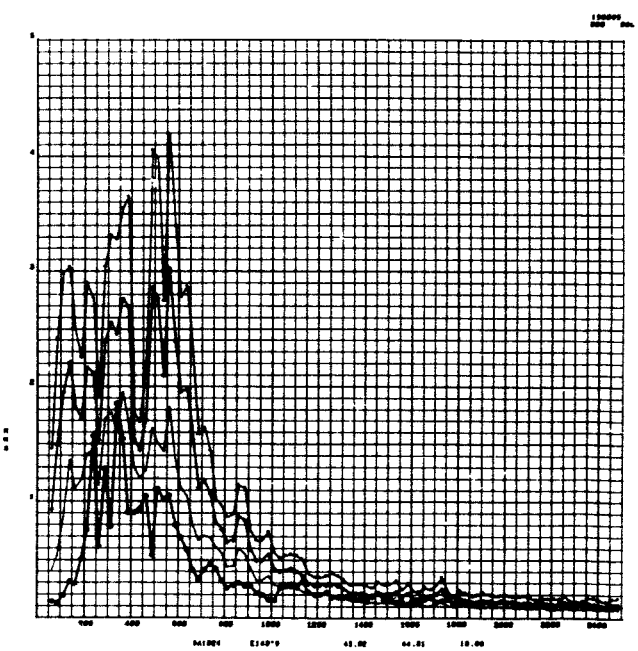
Meas. No.:	E 140-9	Mean:	-0.0023
Description:	Shear Beam Top	S.D.:	6.95
Run No:	SA1024	Skewness:	0.12
Slice Time:	43-44	Kurtosis:	3.14
Calib. Range:	± 30 G	Chi-Square:	30.41
Zone:	2-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
350	1.86	545	1.02
240	1.57	440	0.94
370	1.55	420	0.91
290	1.29	595	0.80
525	1.03	510	0.74



PSD vs. FREQ.



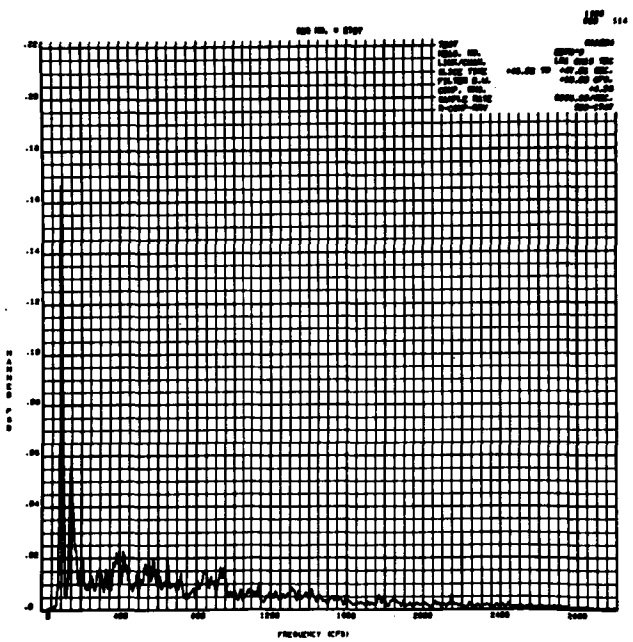
G_{RMS} vs. FREQ.

FIGURE B-22

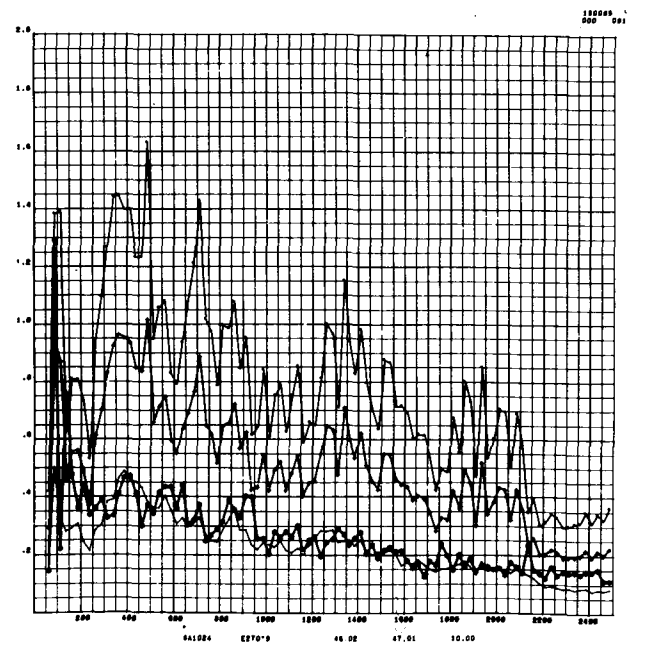
Meas. No.:	E270-9	Mean:	-0.010
Description:	Distributor 9A3	S.D.:	4.36
Run No:	SA1024	Skewness:	0.038
Slice Time:	46-47	Kurtosis:	2.91
Calib. Range:	± 20 G	Chi-Square:	19.65
Zone:	3-1	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
95	1.30	210	0.44
150	0.76	580	0.43
420	0.47	555	0.43
385	0.47	370	0.43
650	0.44	535	0.42



PSD vs. FREQ.



GRMS vs. FREQ.

FIGURE B-23

Meas No:	L28-9	Mean:	0.000000
Description:	Sound Intensity, Sta. 171	S.D.:	0.017
Run No:	SA1024	Skewness:	0.22
Slice Time:	47-48	Kurtosis:	7.79
Calib. Range:	130-150 dB.	Chi-Square:	357.67
Zone:	2	2.5%:	23.34
		5%:	21.03

PREDOMINANT FREQUENCIES

FREQUENCY	RMS AMPLITUDE	FREQUENCY	RMS AMPLITUDE
310	0.0019	155	0.0017
225	0.0019	210	0.0017
140	0.0019	125	0.0017
265	0.0018	420	0.0016
100	0.0017	175	0.0016

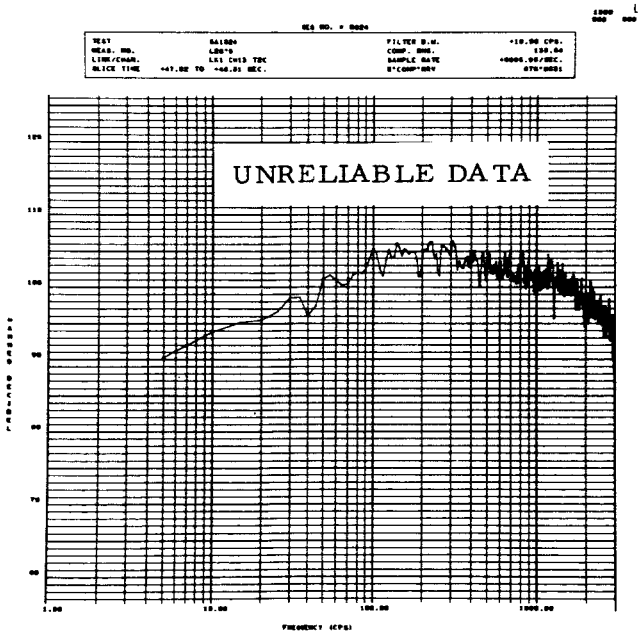


FIGURE B-24

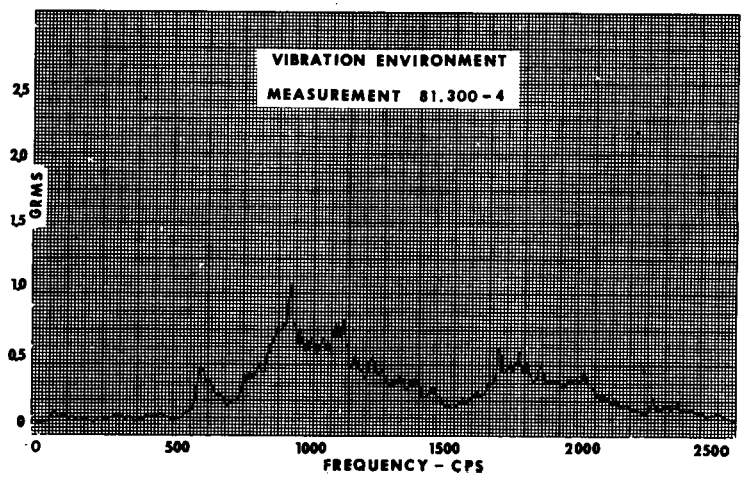


FIGURE B-25

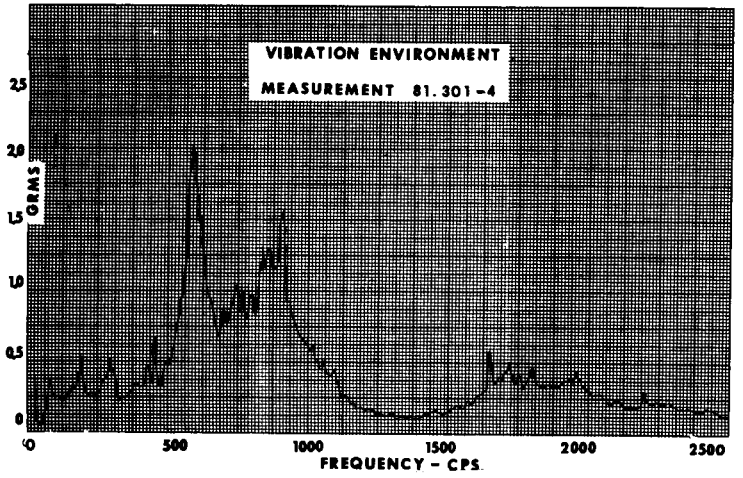


FIGURE B-26

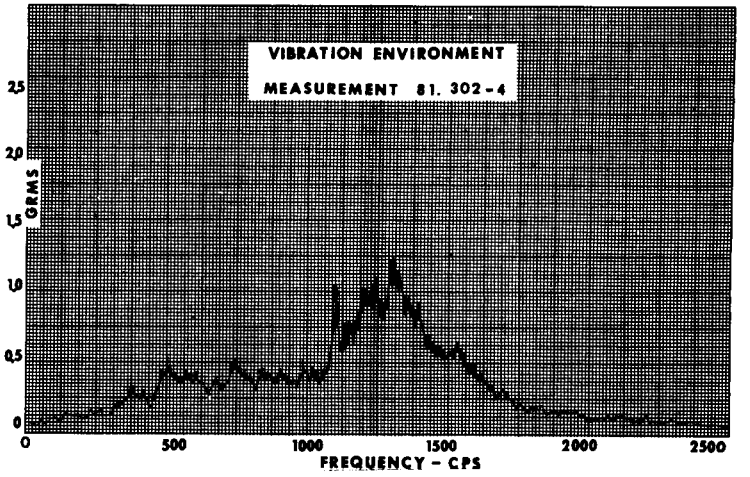


FIGURE B-27

VIBRATION ENVIRONMENT, ENGINE 4 SHEAR BEAM

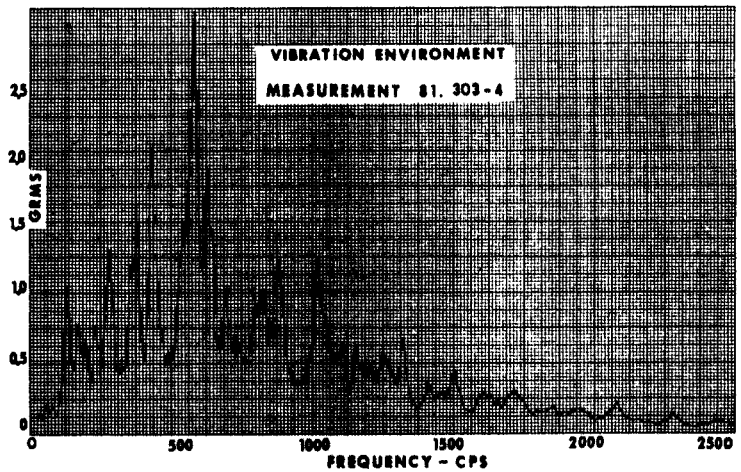


FIGURE B-28

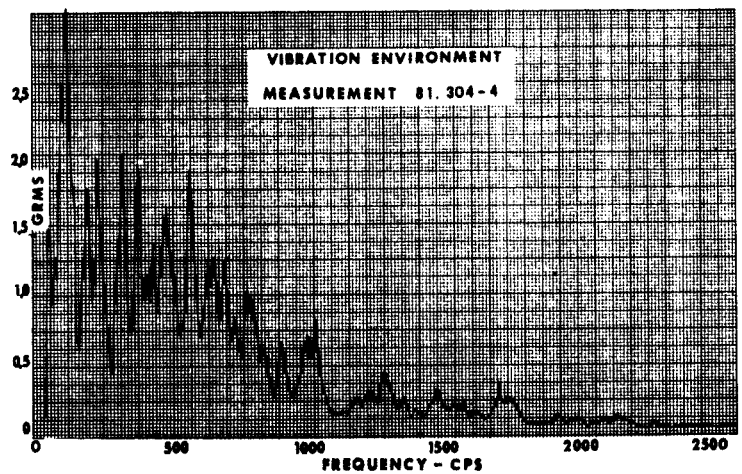


FIGURE B-29

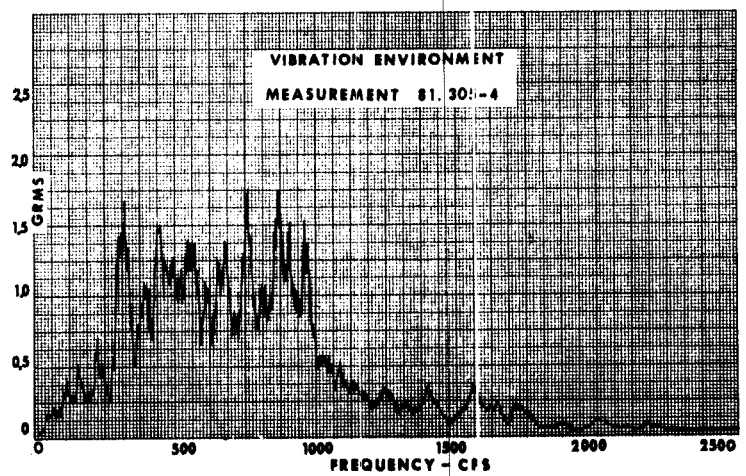


FIGURE B-30

VIBRATION ENVIRONMENT, ENGINE 4 SHEAR BEAM

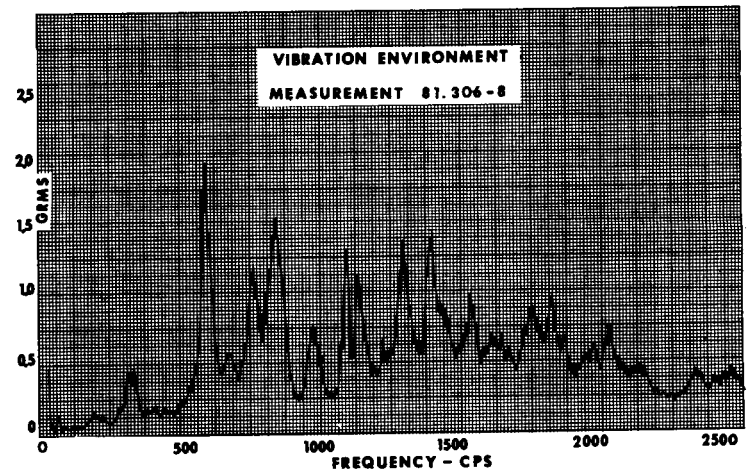


FIGURE B-31

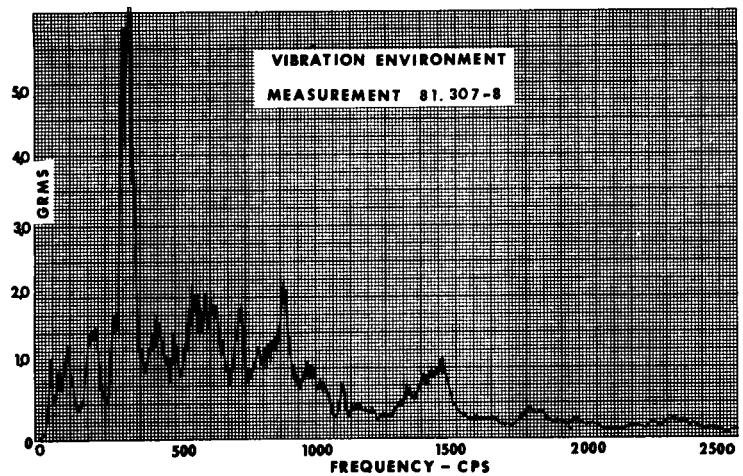


FIGURE B-32

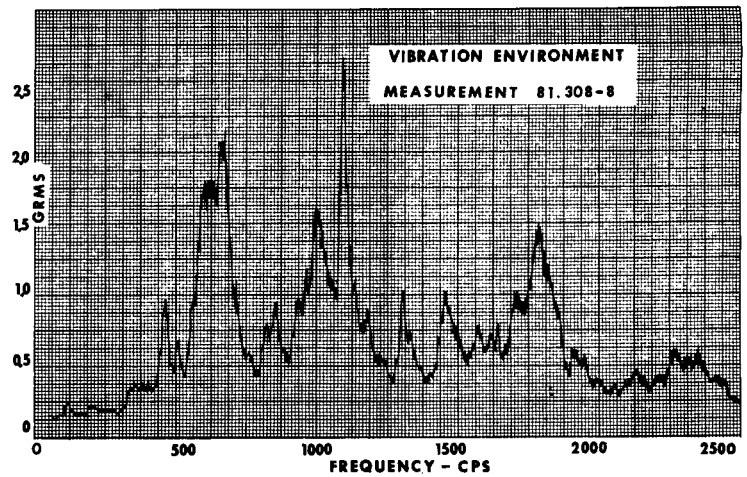


FIGURE B-33

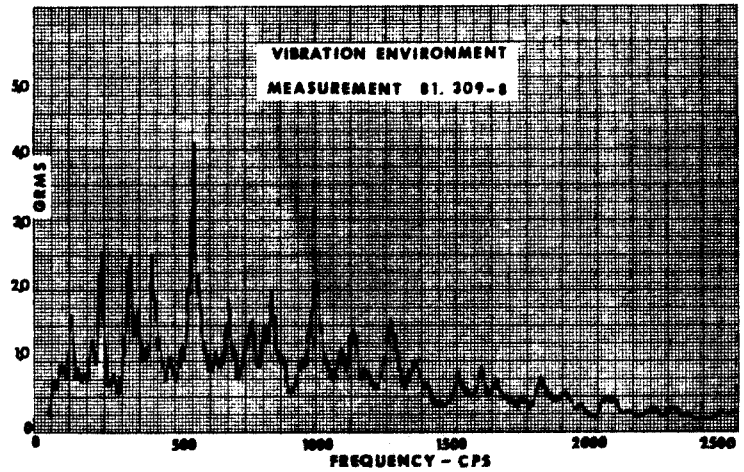


FIGURE B-34

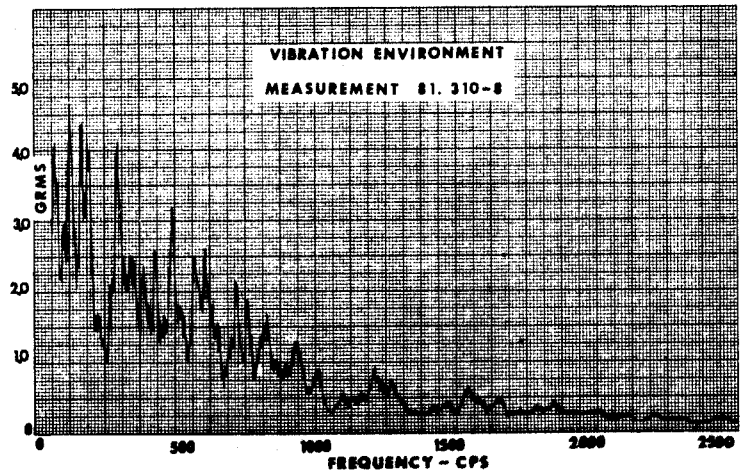


FIGURE B-35

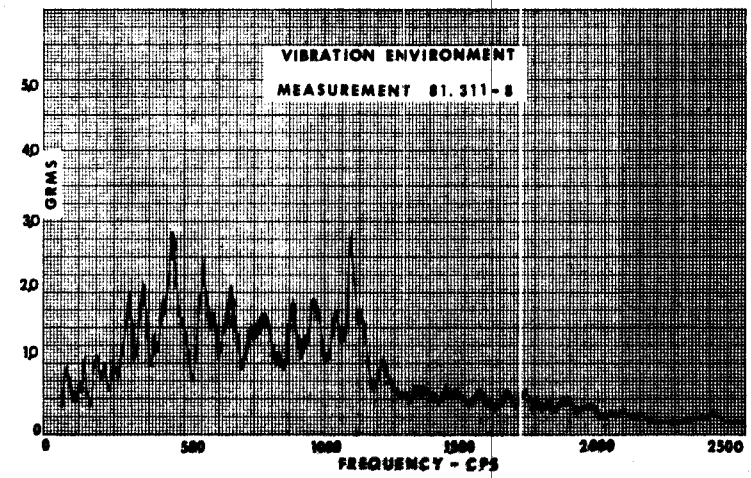


FIGURE B-36

VIBRATION ENVIRONMENT, ENGINE 8 SHEAR BEAM

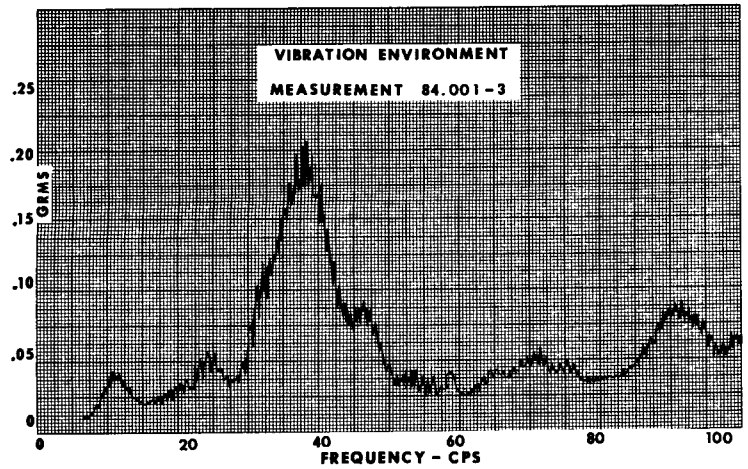


FIGURE B-37

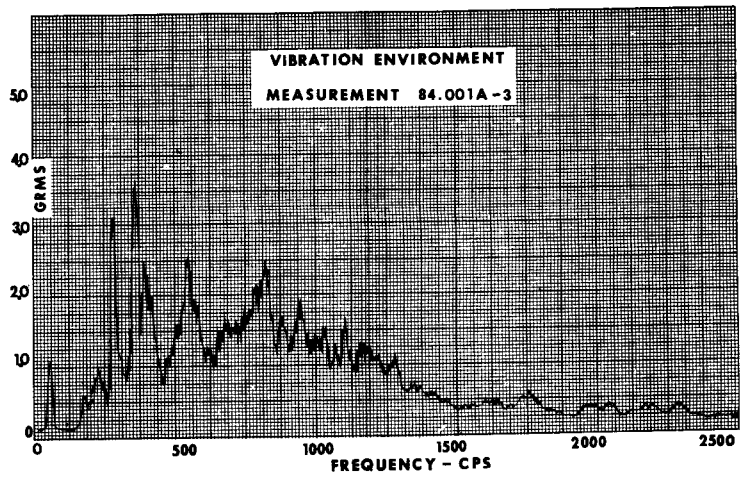


FIGURE B-38

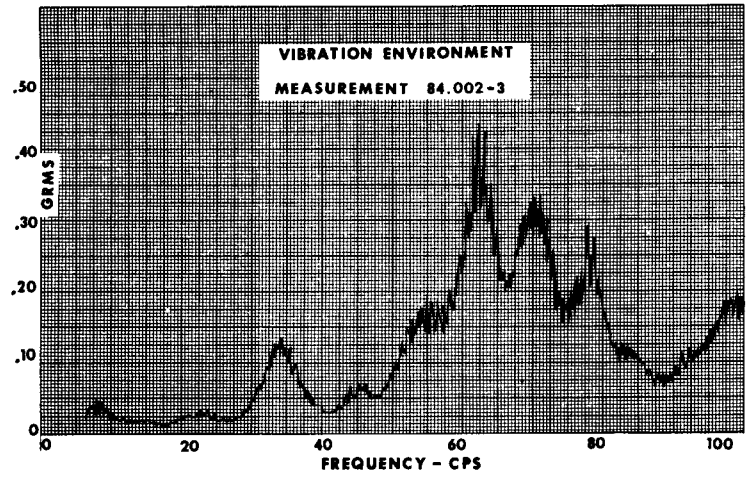


FIGURE B-39

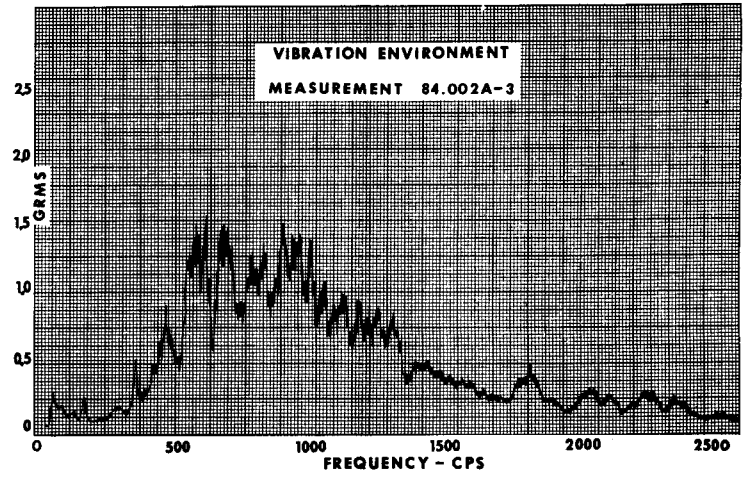


FIGURE B-40

VIBRATION ENVIRONMENT, UPPER BULKHEAD OF F-3

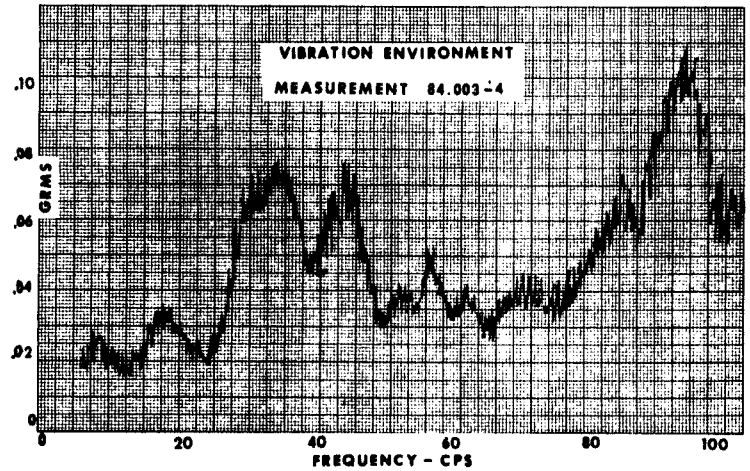


FIGURE B-41

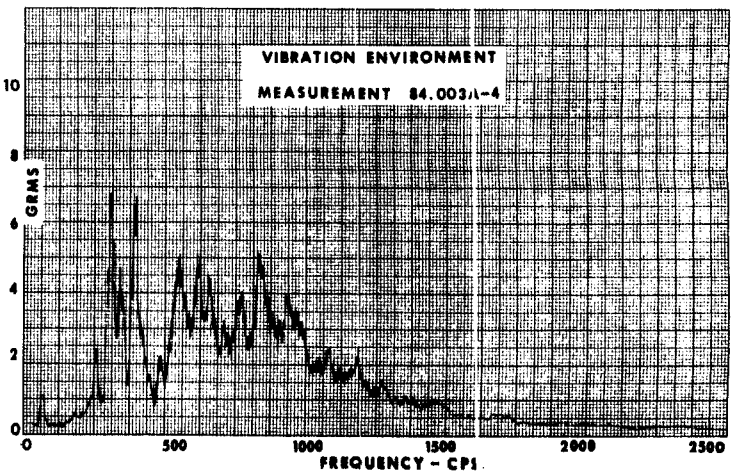


FIGURE B-42

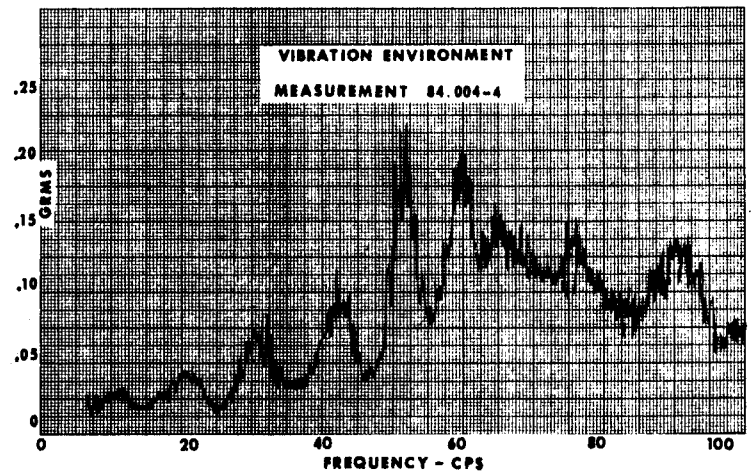


FIGURE B-43

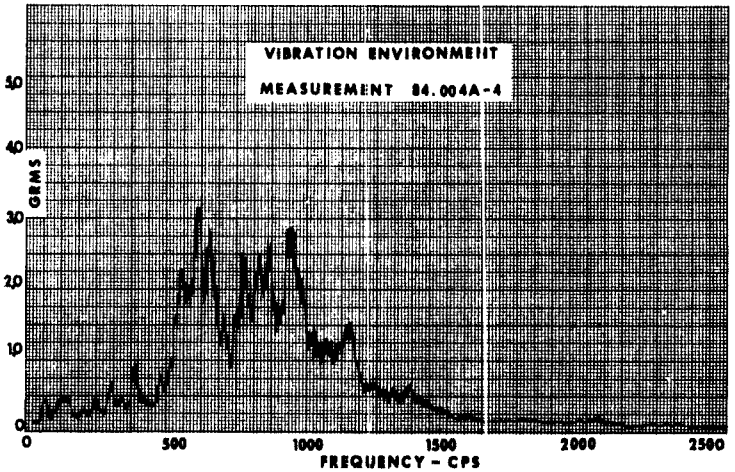


FIGURE B-44

VIBRATION ENVIRONMENT, UPPER BULKHEAD OF F-4

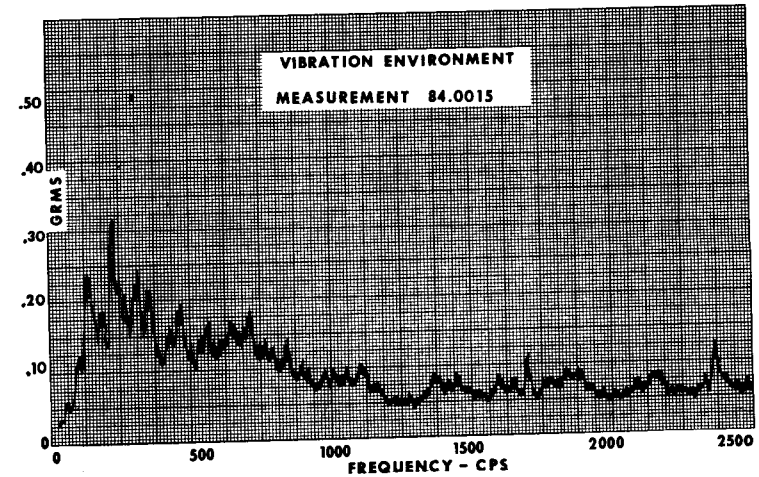


FIGURE B-45

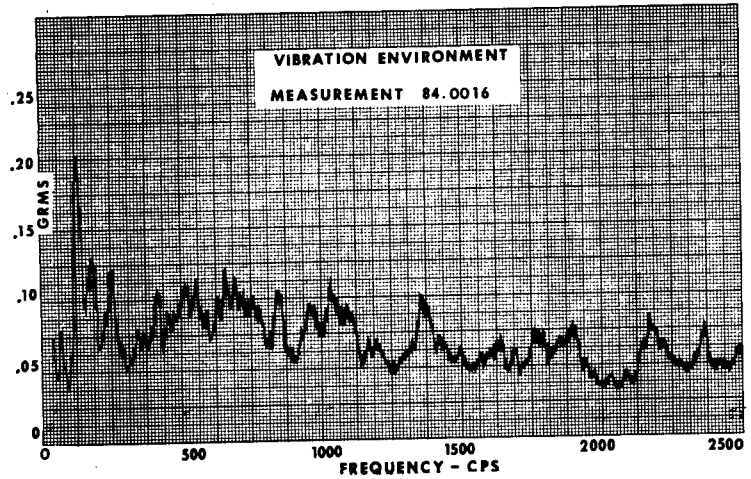


FIGURE B-46

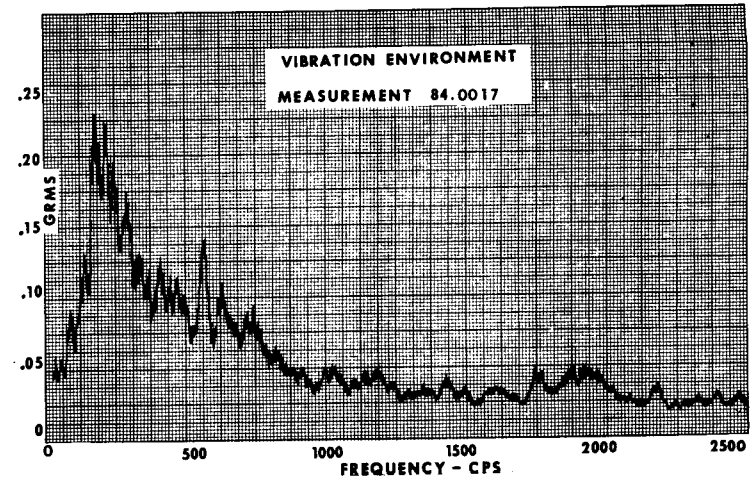


FIGURE B-47

VIBRATION ENVIRONMENT, SPIDER BEAM

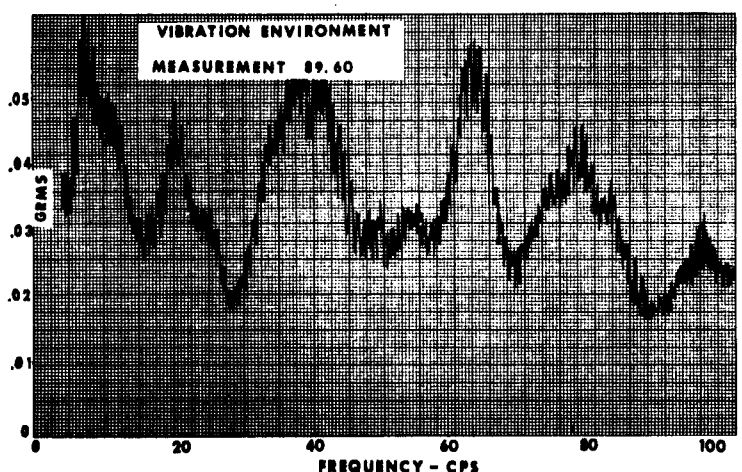


FIGURE B-48

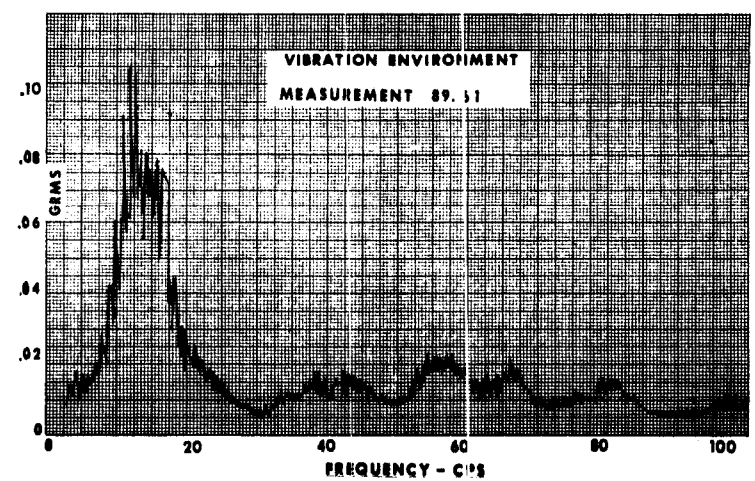


FIGURE B-49

VIBRATION ENVIRONMENT, SPIDER BEAM

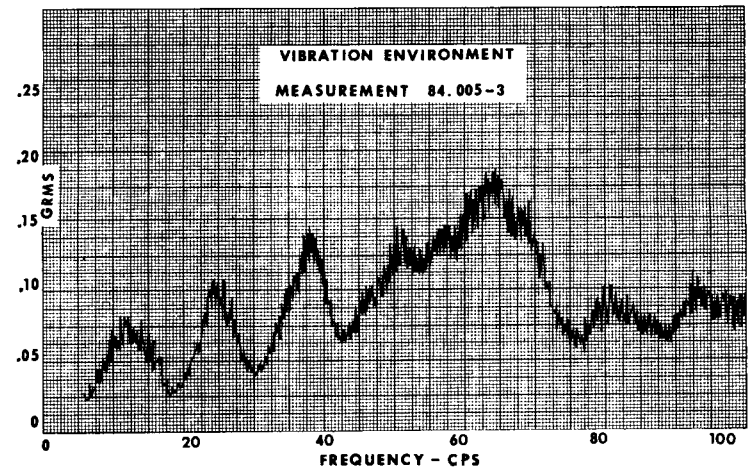


FIGURE B-50

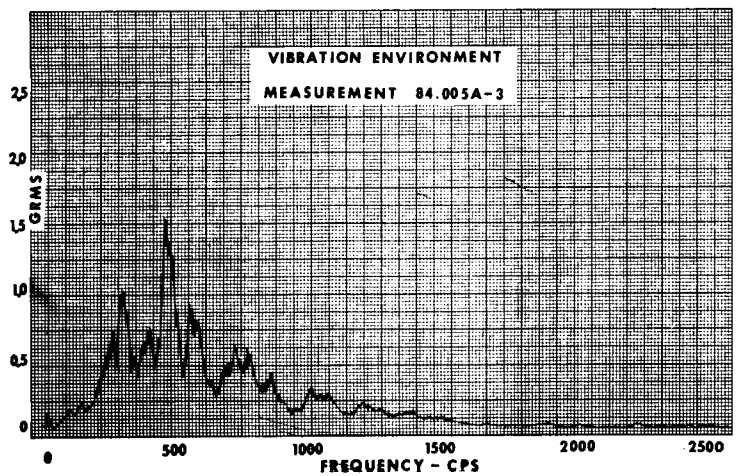


FIGURE B-51

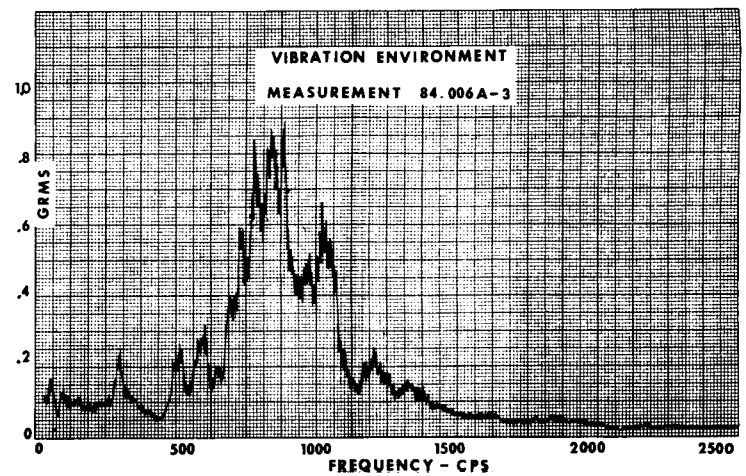


FIGURE B-52

VIBRATION ENVIRONMENT, LOWER BULKHEAD OF F-3

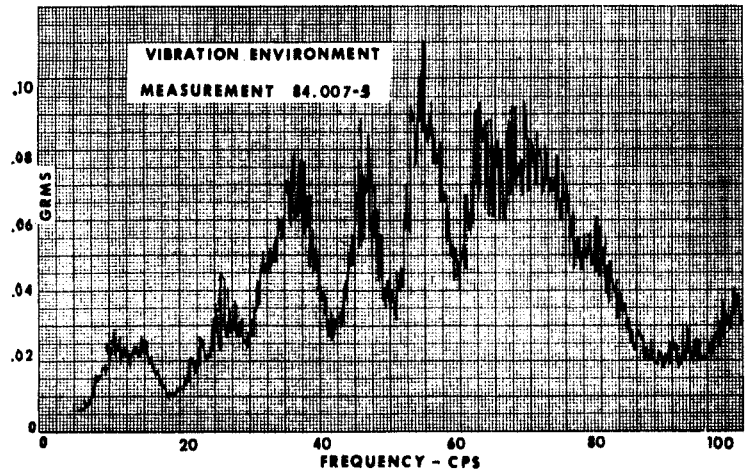


FIGURE B-53

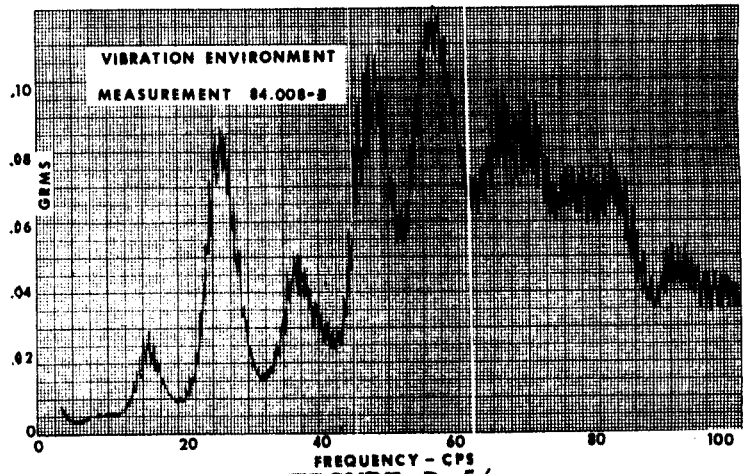


FIGURE B-54

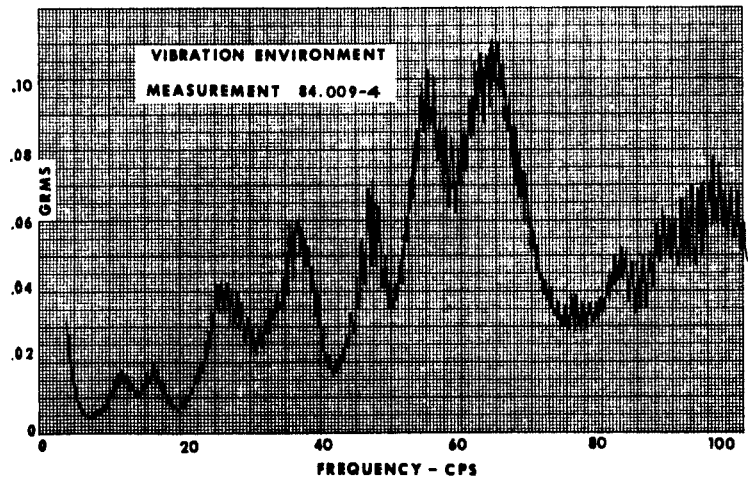


FIGURE B-55

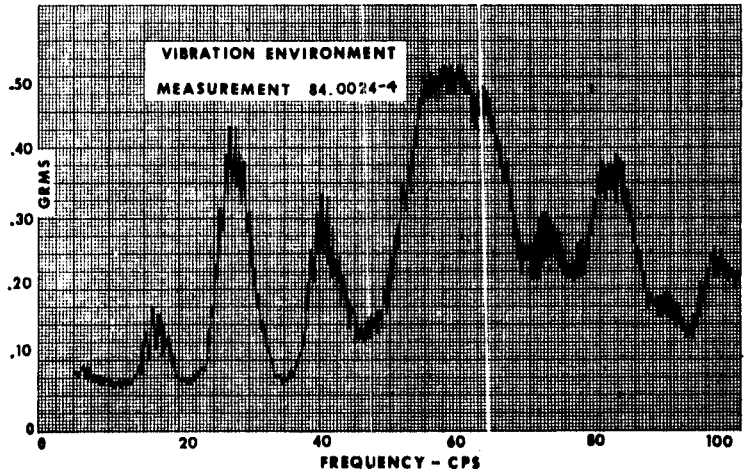


FIGURE B-56

VIBRATION ENVIRONMENT, FUEL INTERCONNECT LINE AND FLANGE

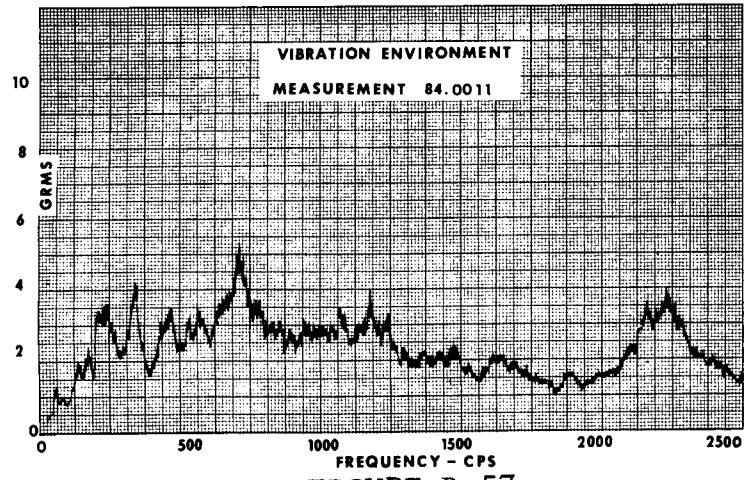


FIGURE B-57

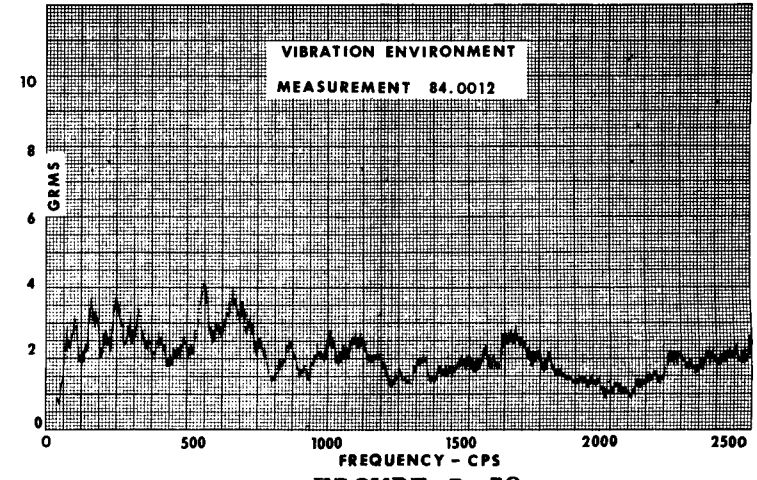


FIGURE B-58

VIBRATION ENVIRONMENT, SHROUD

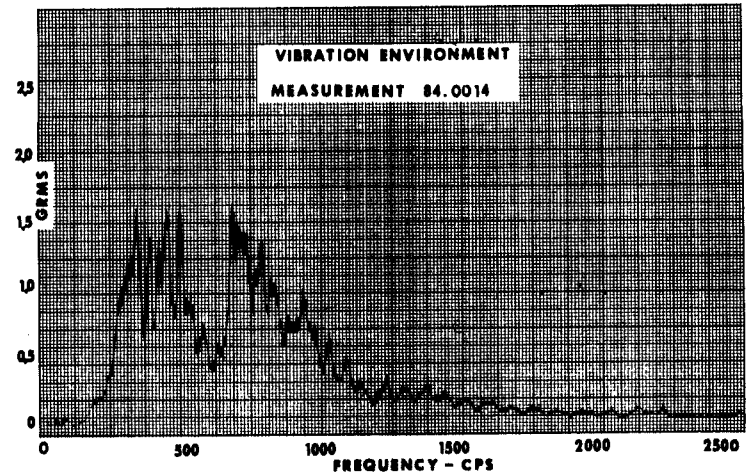


FIGURE B-59

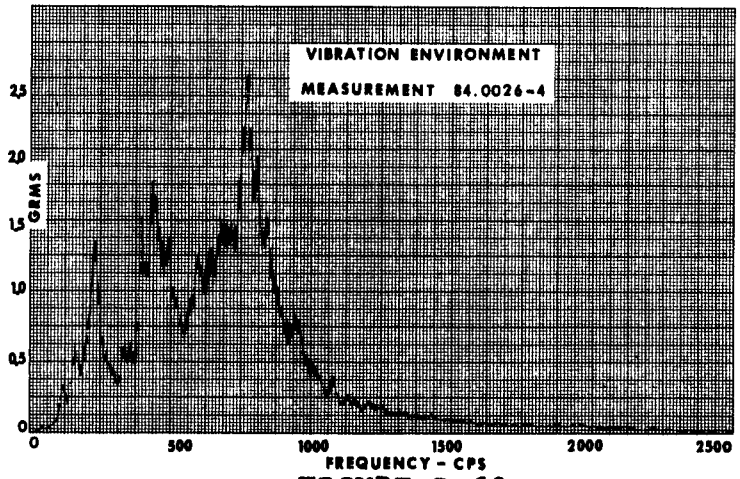


FIGURE B-60

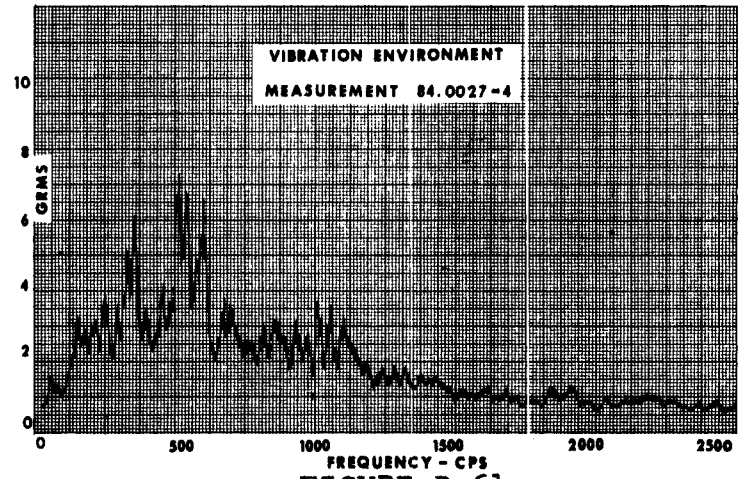


FIGURE B-61

VIBRATION ENVIRONMENT, FUEL TANK SKIN

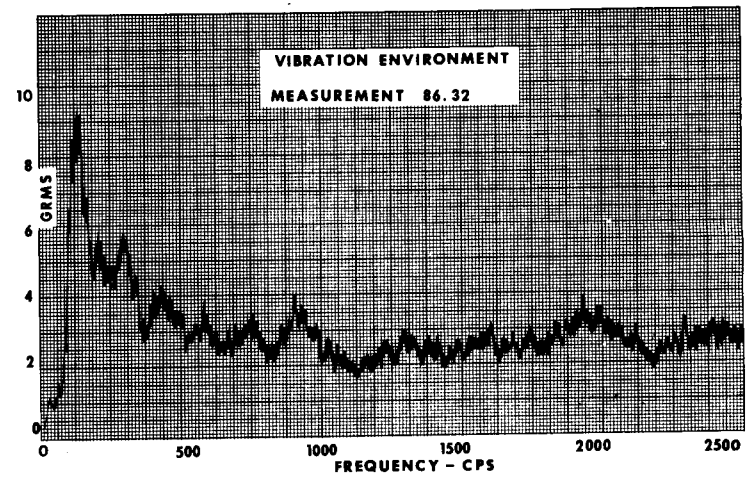


FIGURE B-62

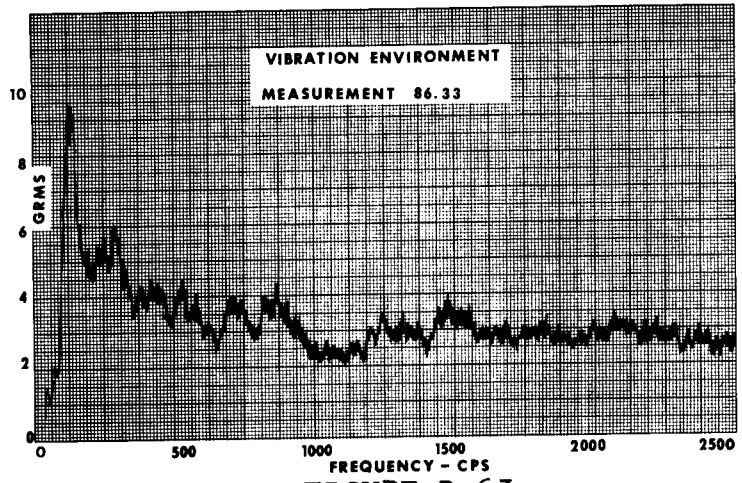


FIGURE B-63

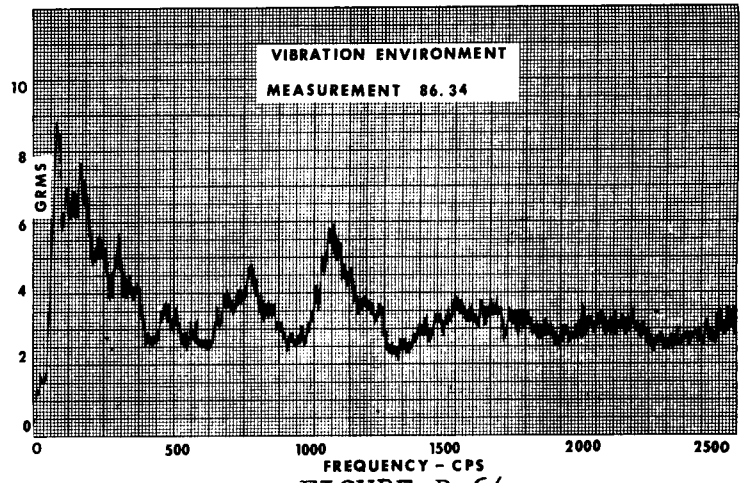


FIGURE B-64

VIBRATION ENVIRONMENT, HEAT SHIELD PANELS

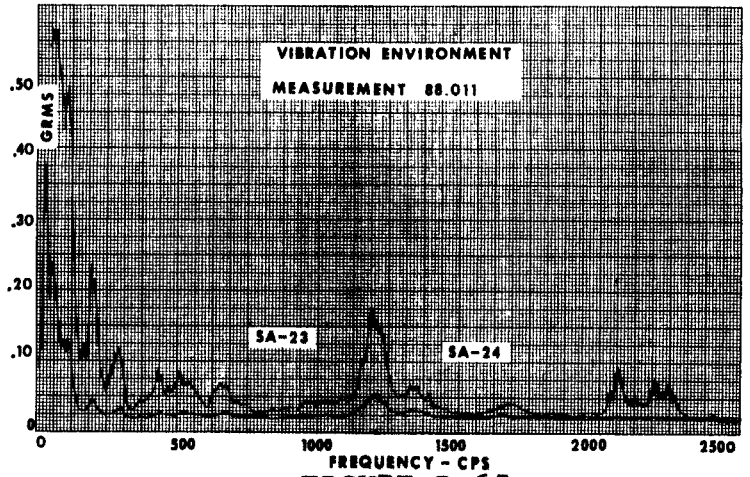


FIGURE B-65

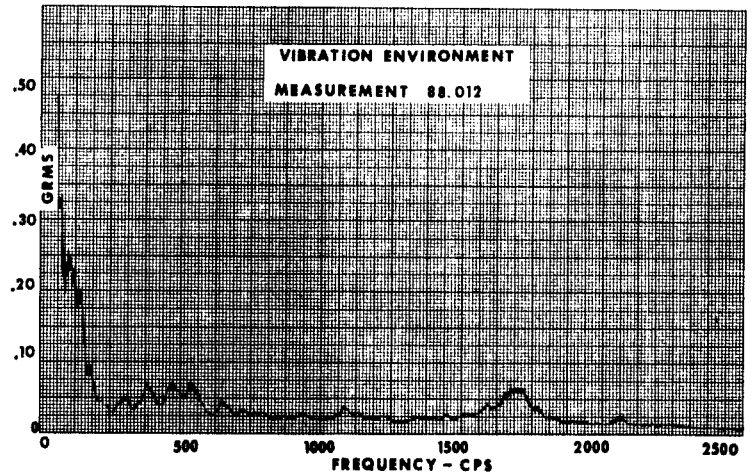


FIGURE B-66

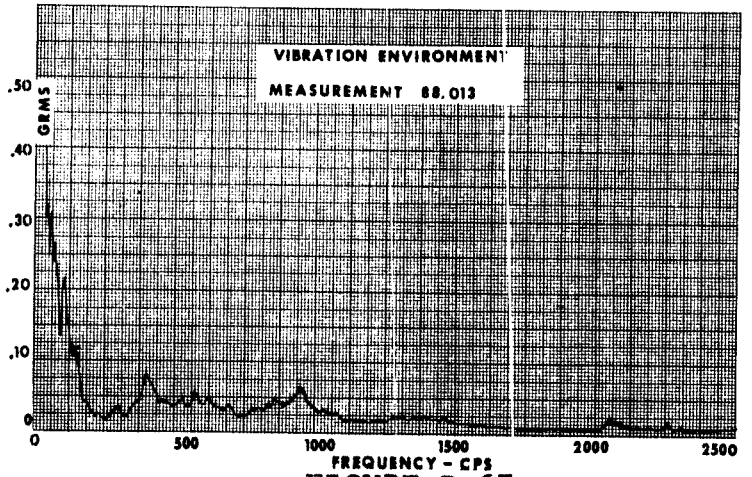


FIGURE B-67

VIBRATION ENVIRONMENT, F-2 INSTRUMENT COMPARTMENT

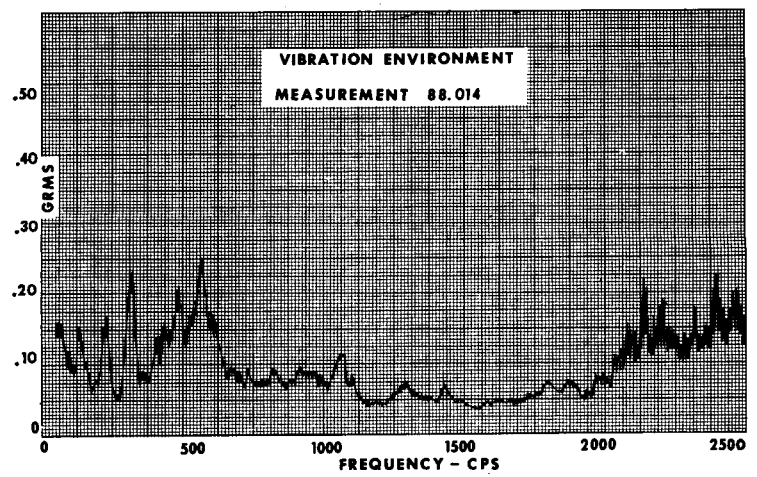


FIGURE B-68

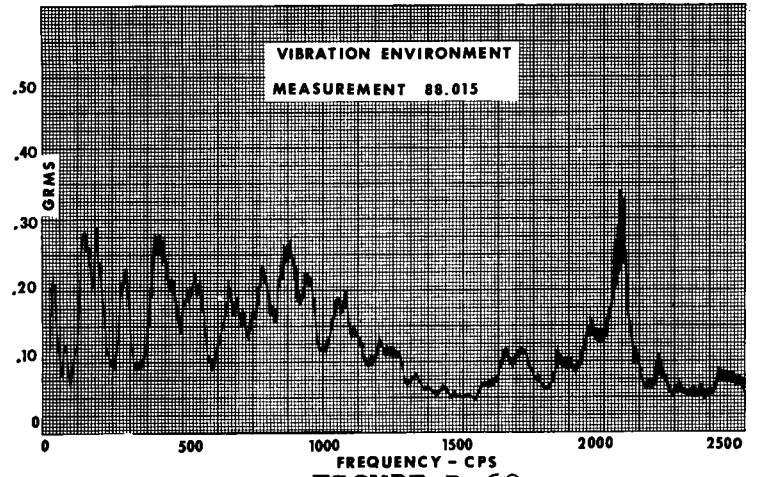


FIGURE B-69

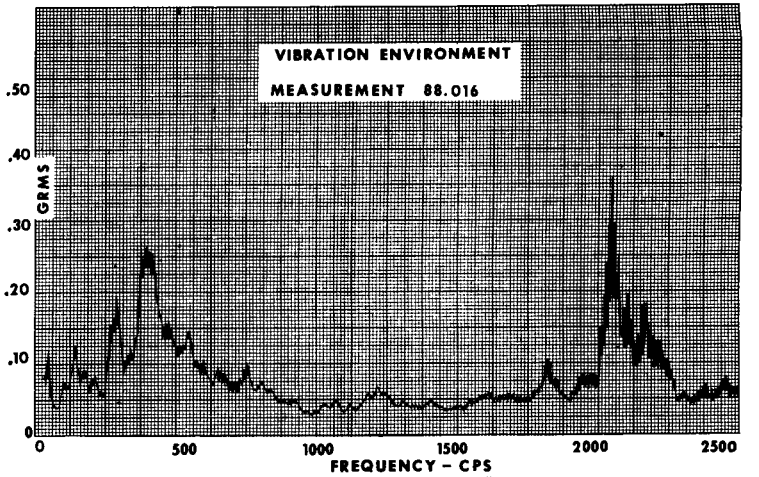


FIGURE B-70

VIBRATION ENVIRONMENT, F-2 INSTRUMENT COMPARTMENT

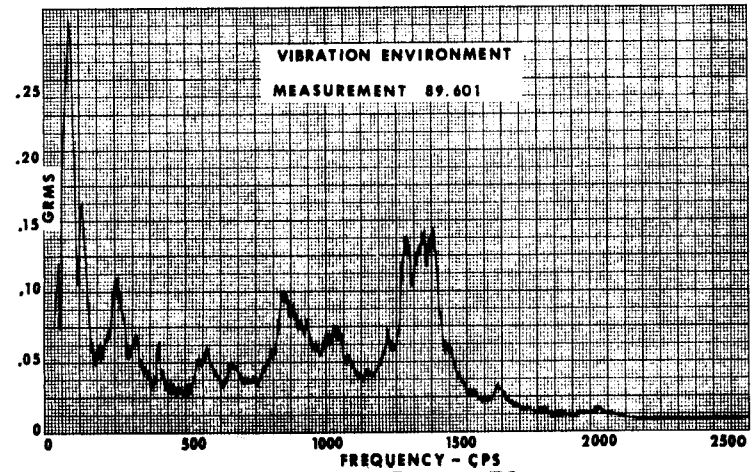


FIGURE B-71

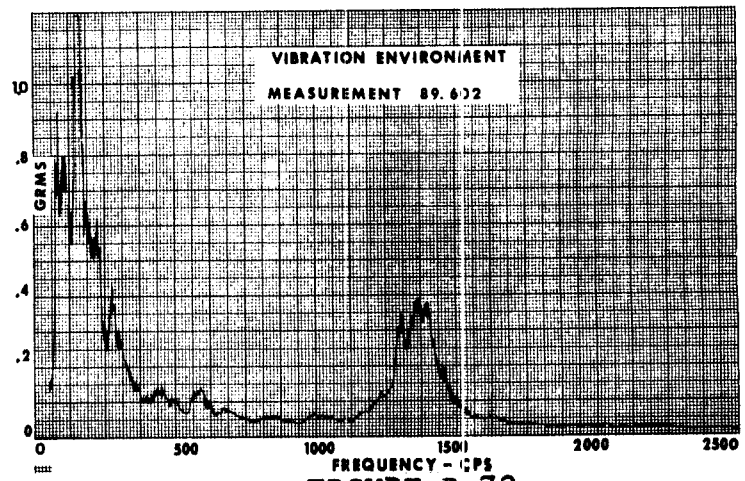


FIGURE B-72

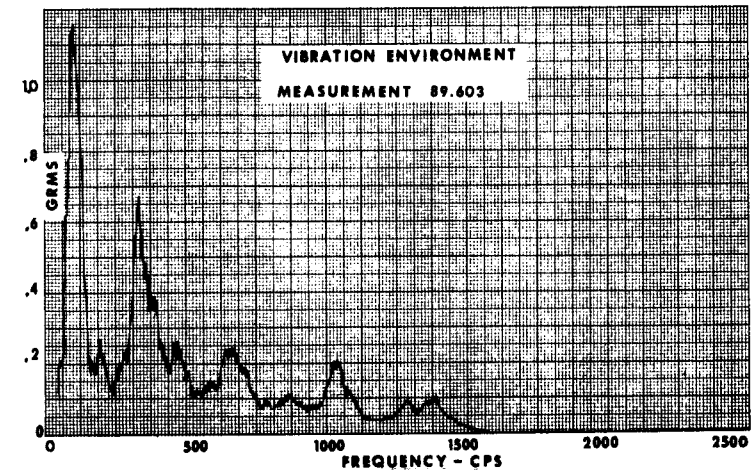


FIGURE B-73

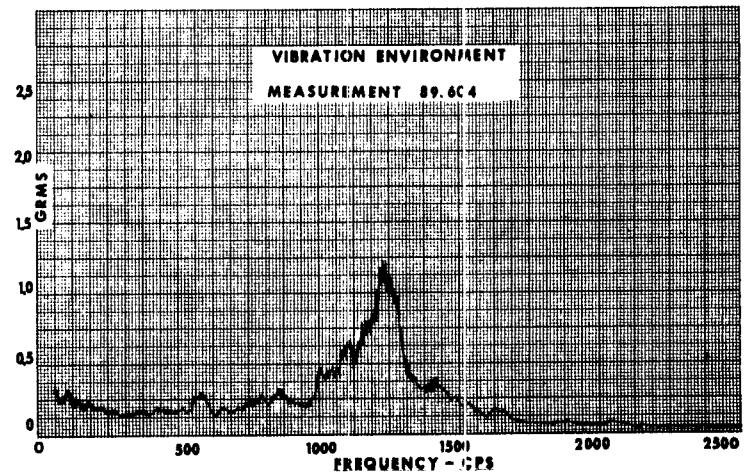


FIGURE B-74

VIBRATION ENVIRONMENT, F-1 AFT SKIRT

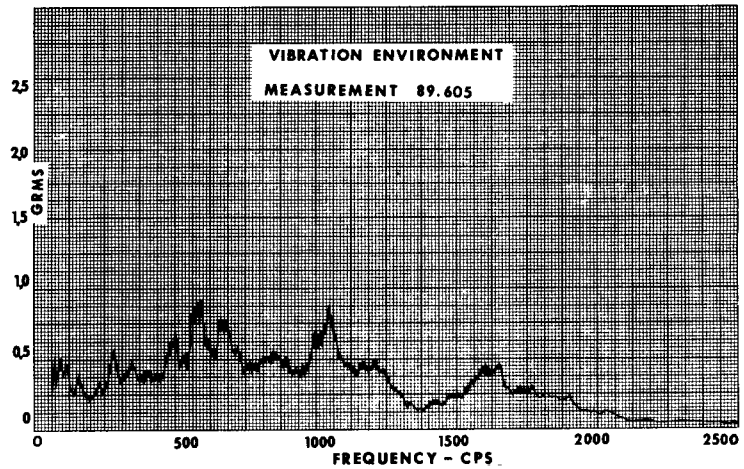


FIGURE B-75

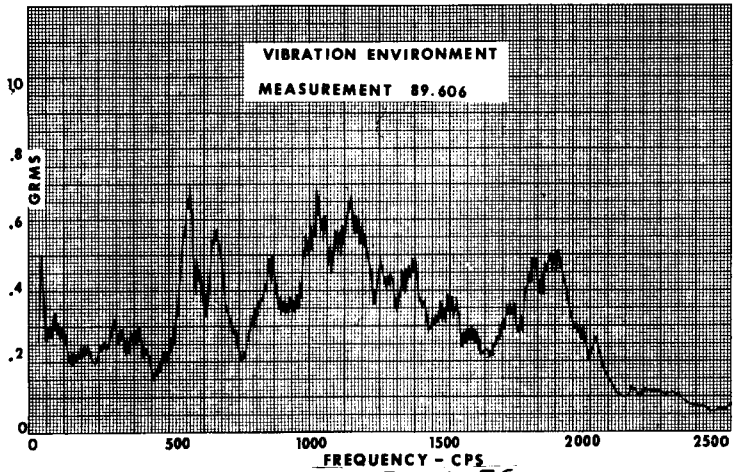


FIGURE B-76

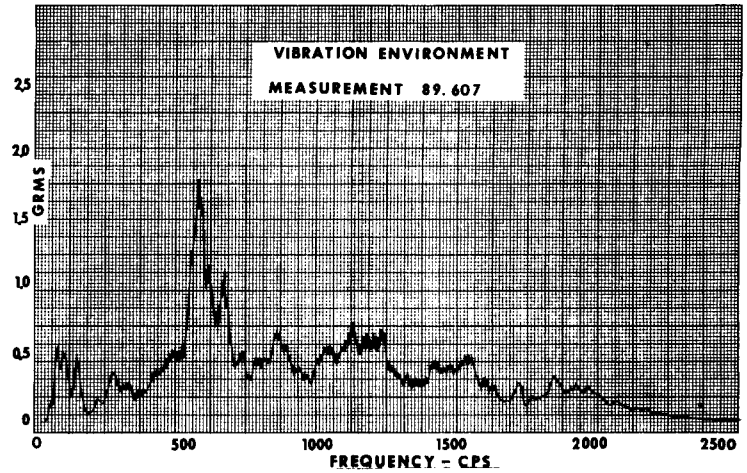


FIGURE B-77

VIBRATION ENVIRONMENT, F-1 AFT SKIRT

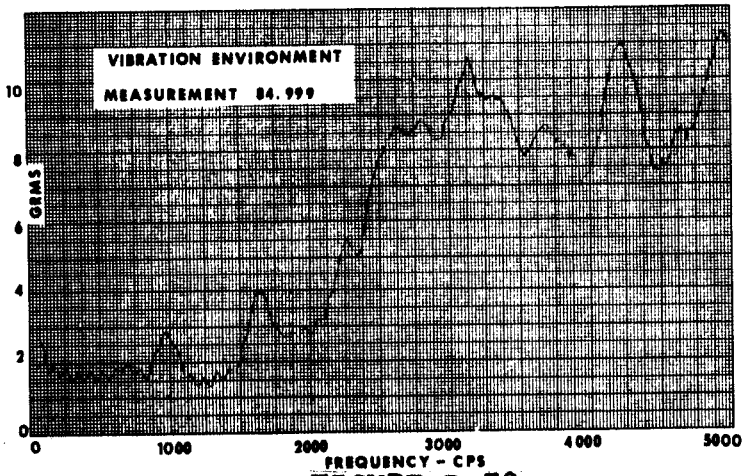


FIGURE B-78

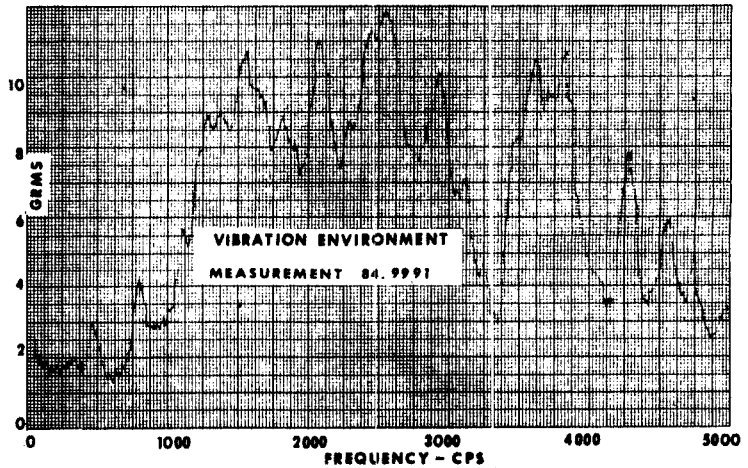
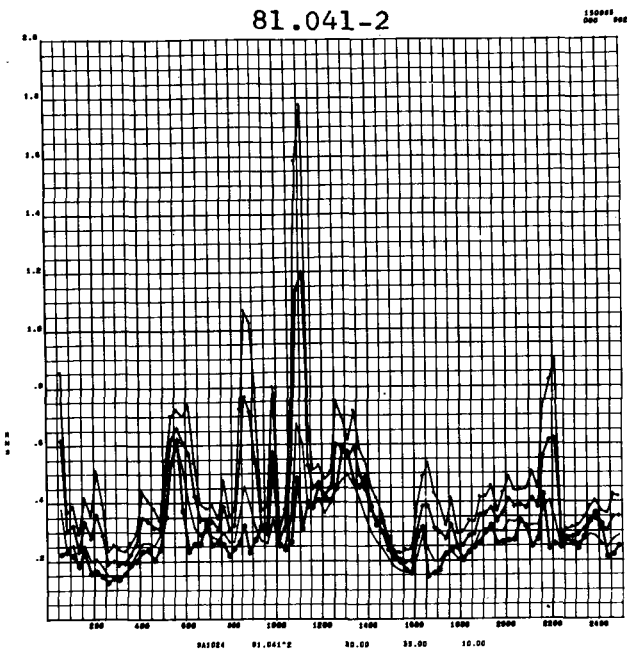


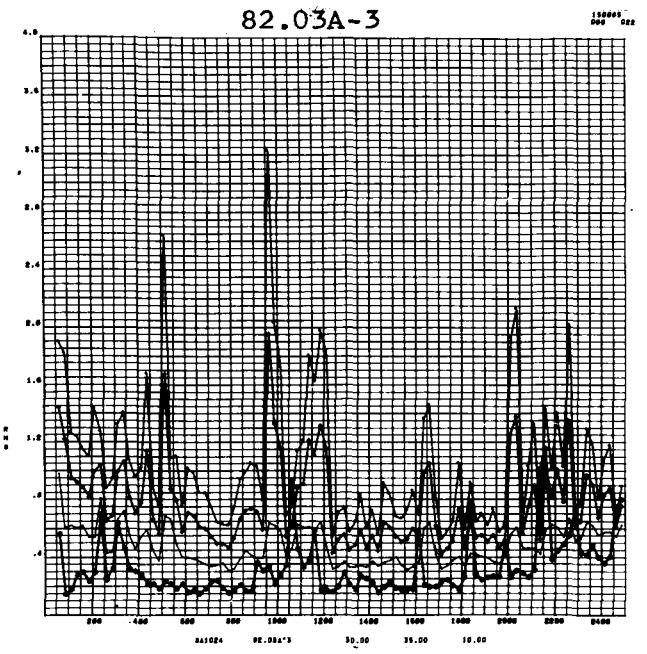
FIGURE B-79

VIBRATION ENVIRONMENT, GOX LINE



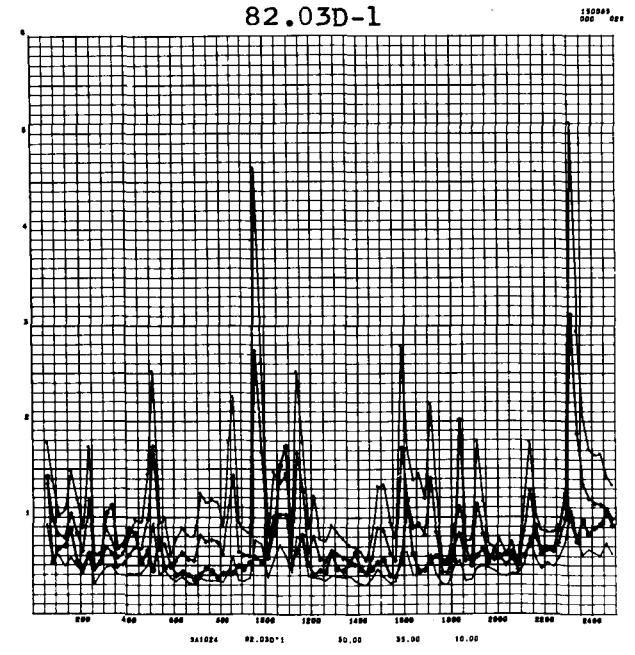
G_{RMS} vs. FREQ.

FIGURE B-80



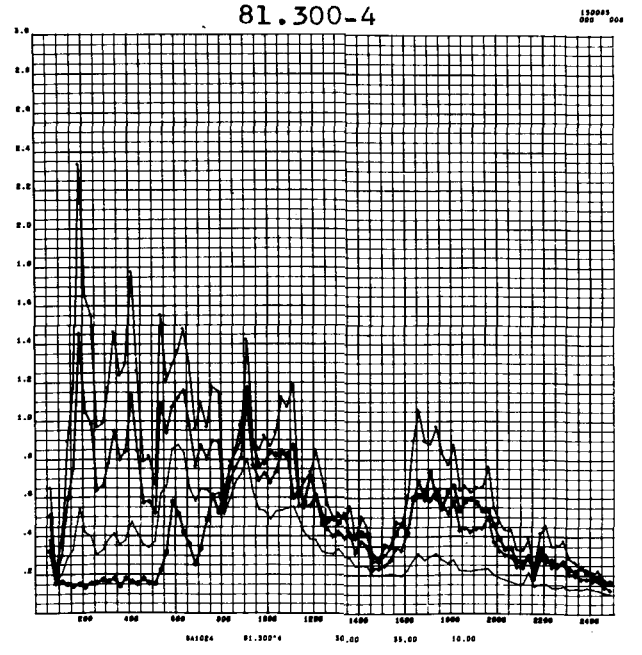
G_{RMS} vs. FREQ.

FIGURE B-81



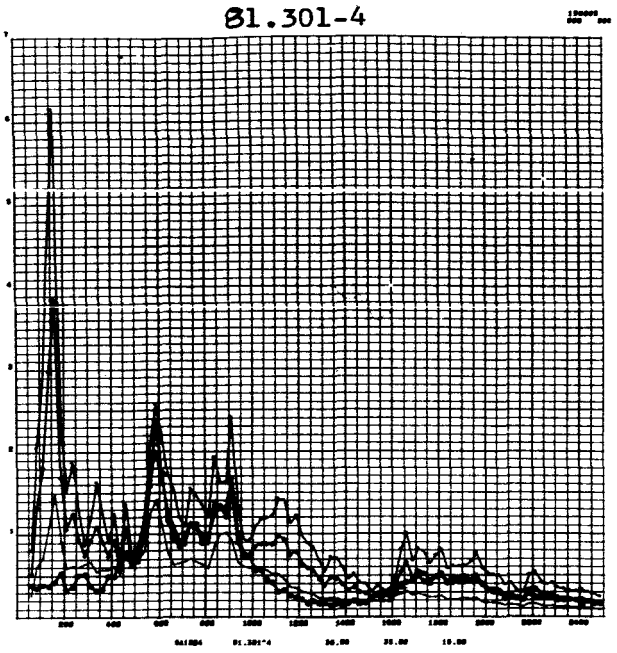
G_{RMS} vs. FREQ.

FIGURE B-82



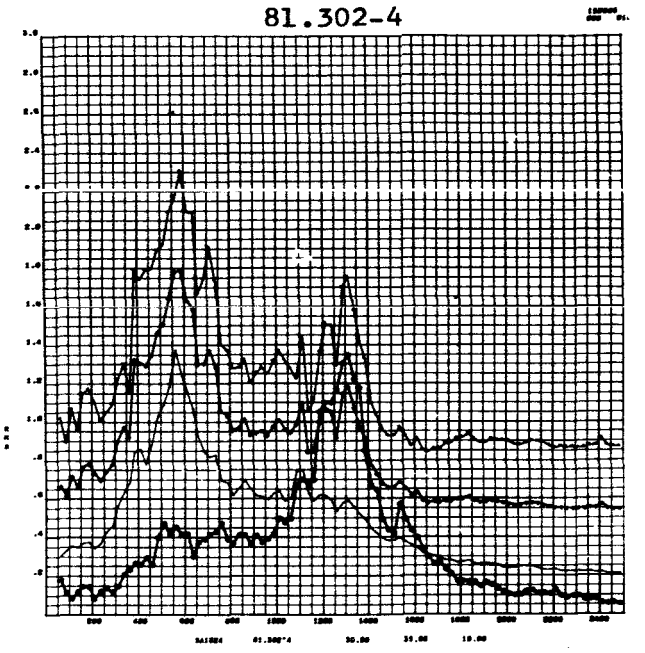
G_{RMS} vs. FREQ.

FIGURE B-83



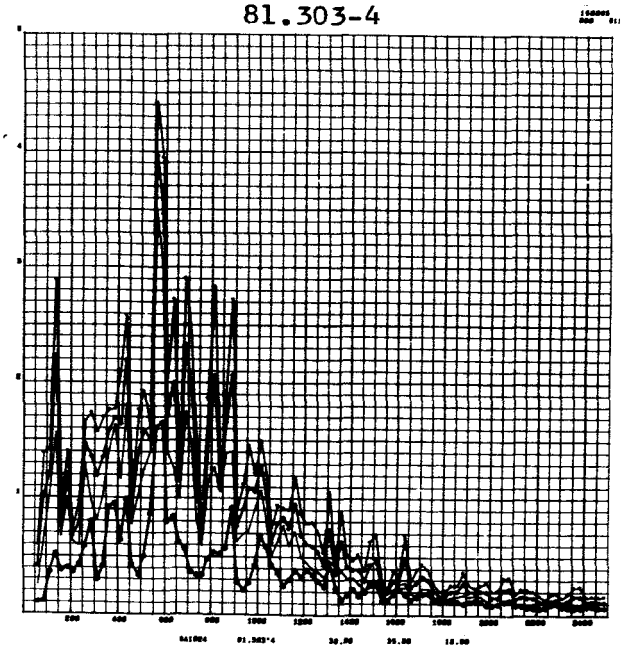
G_{RMS} vs. FREQ.

FIGURE B-84



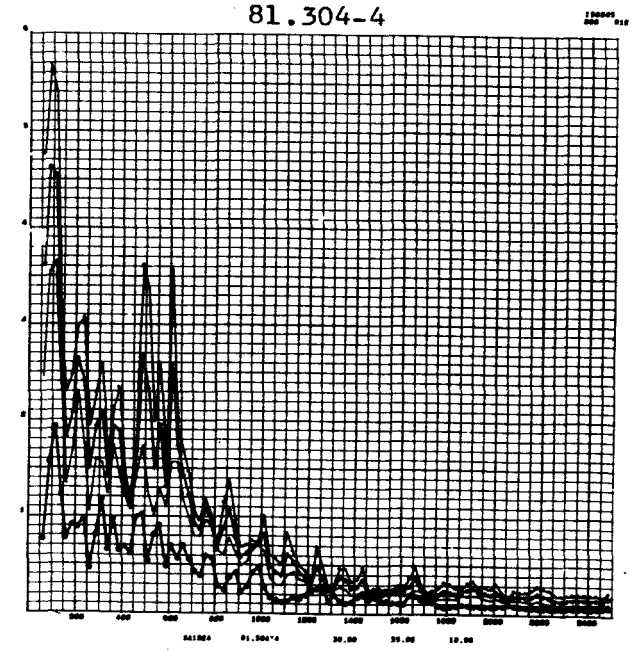
G_{RMS} vs. FREQ.

FIGURE B-85



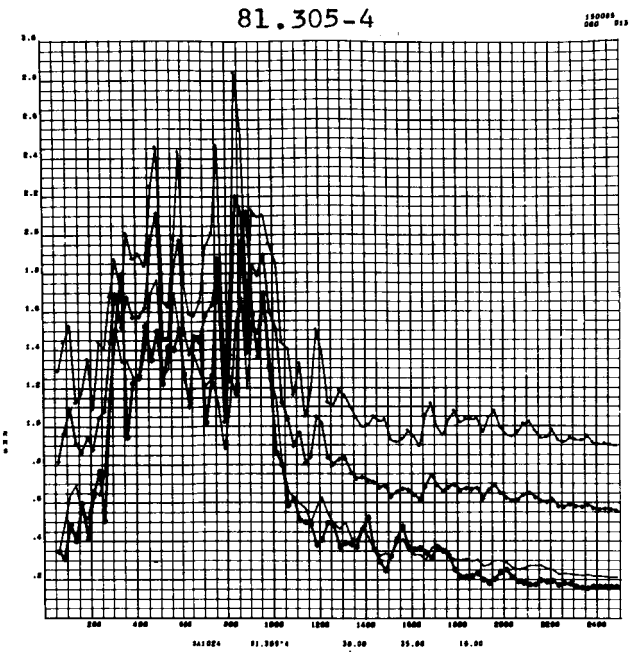
G_{RMS} vs. FREQ.

FIGURE B-86



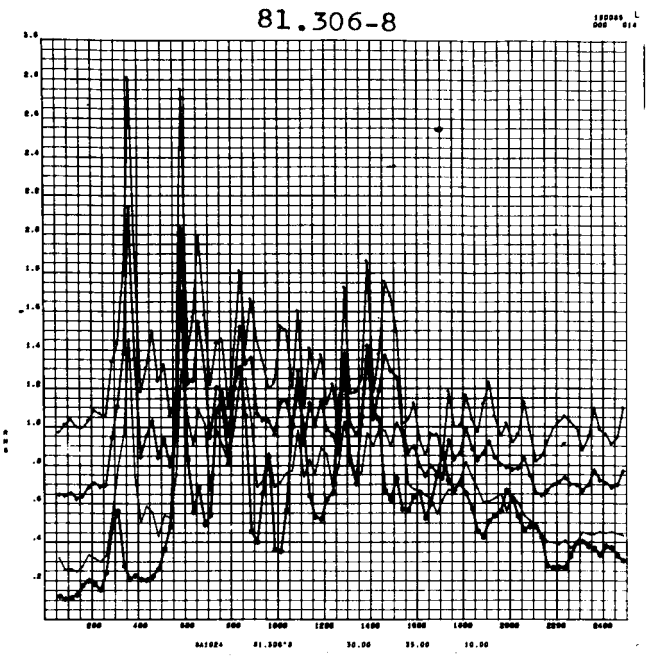
G_{RMS} vs. FREQ.

FIGURE B-87



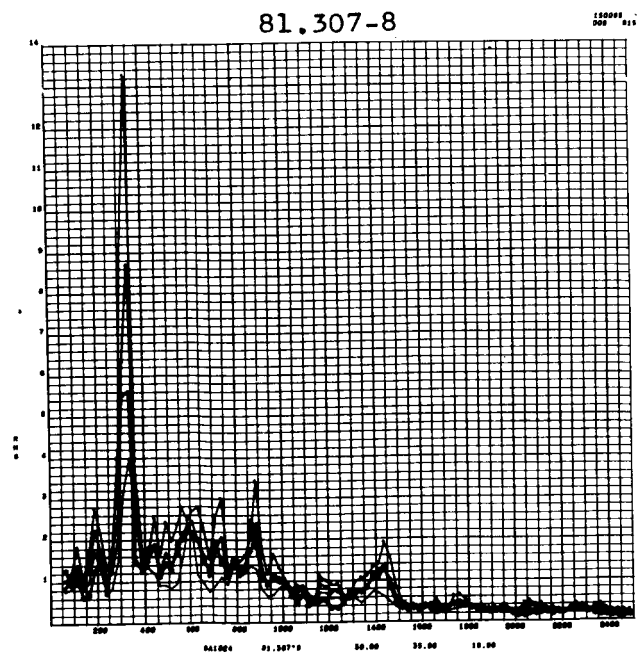
G_{RMS} vs. FREQ.

FIGURE B-88



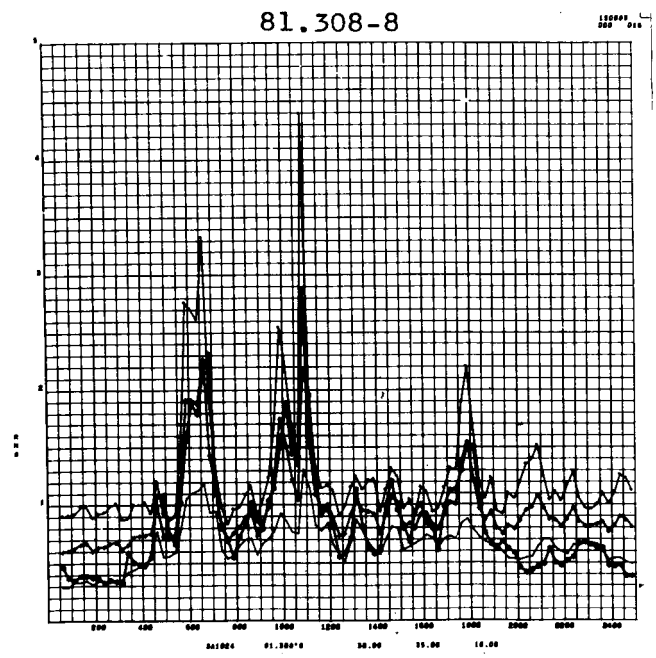
G_{RMS} vs. FREQ.

FIGURE B-89



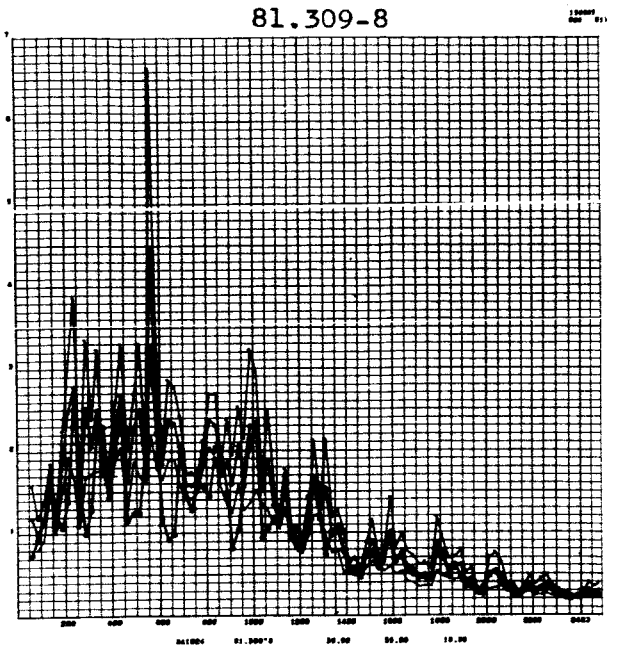
G_{RMS} vs. FREQ.

FIGURE B-90



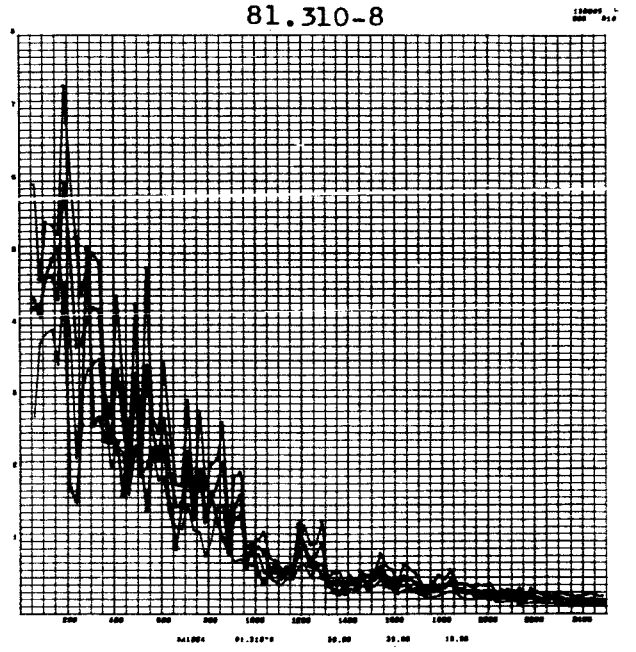
G_{RMS} vs. FREQ.

FIGURE B-91



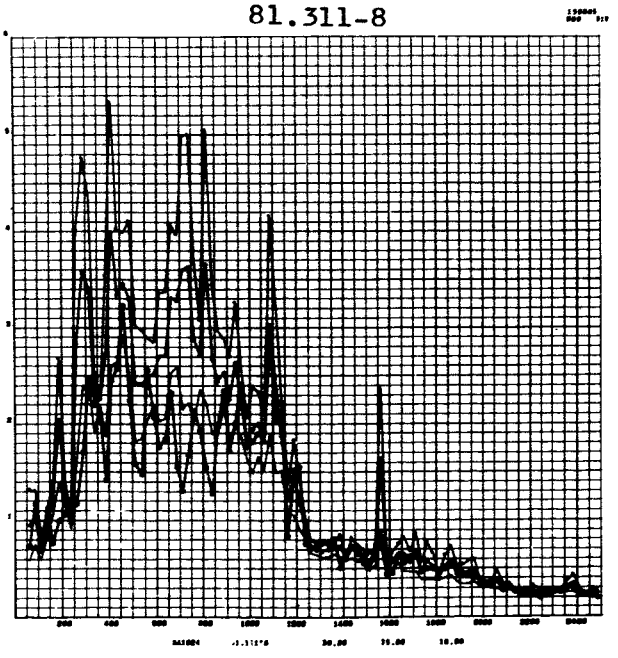
G_{RMS} vs. FREQ.

FIGURE B-92



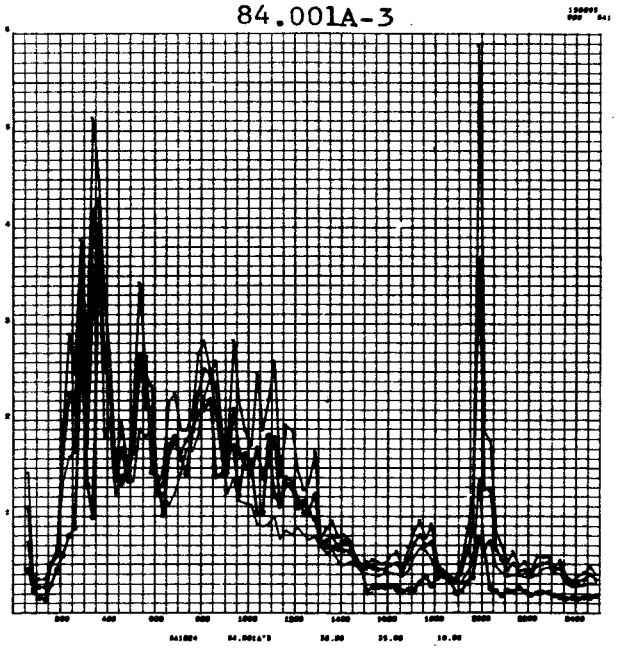
G_{RMS} vs. FREQ.

FIGURE B-93



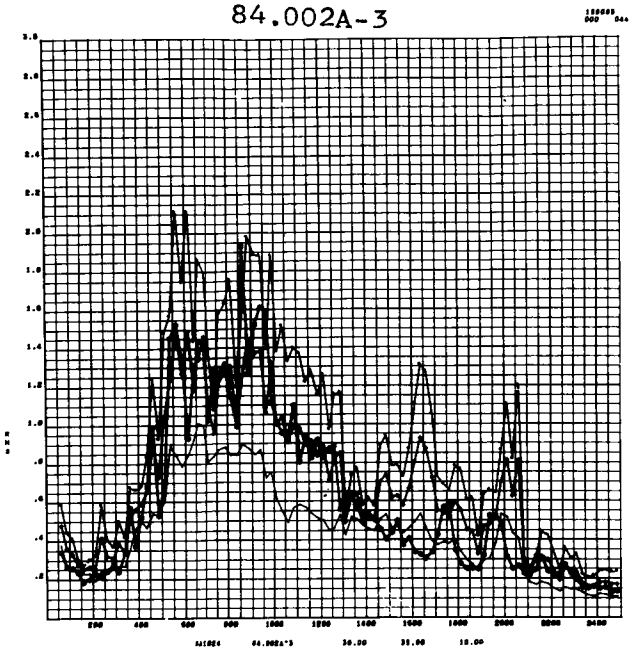
G_{RMS} vs. FREQ.

FIGURE B-94



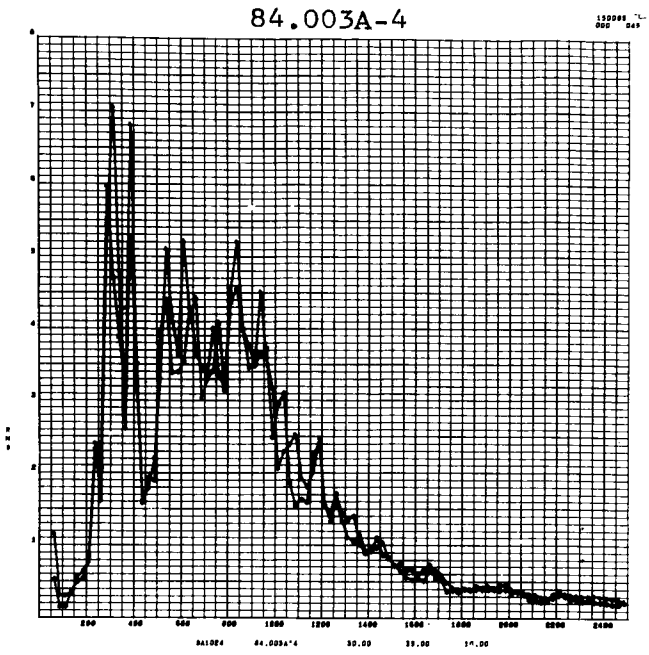
G_{RMS} vs. FREQ

FIGURE B-95



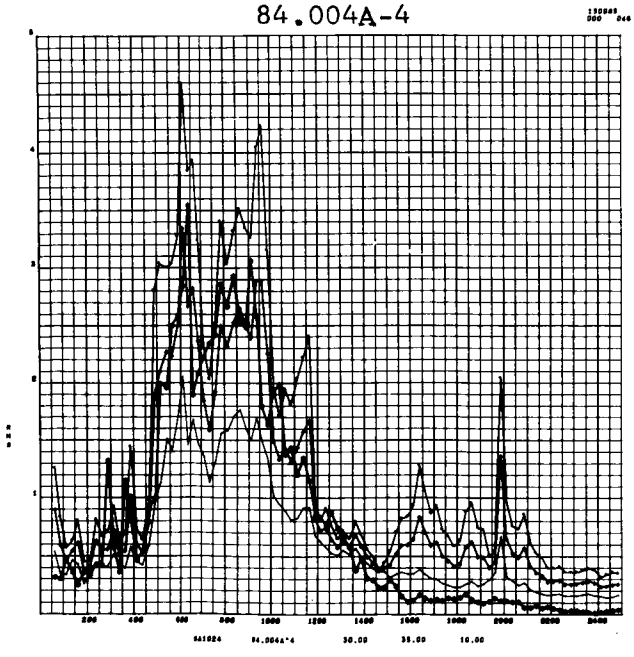
GRMS vs. FREQ.

FIGURE B-96



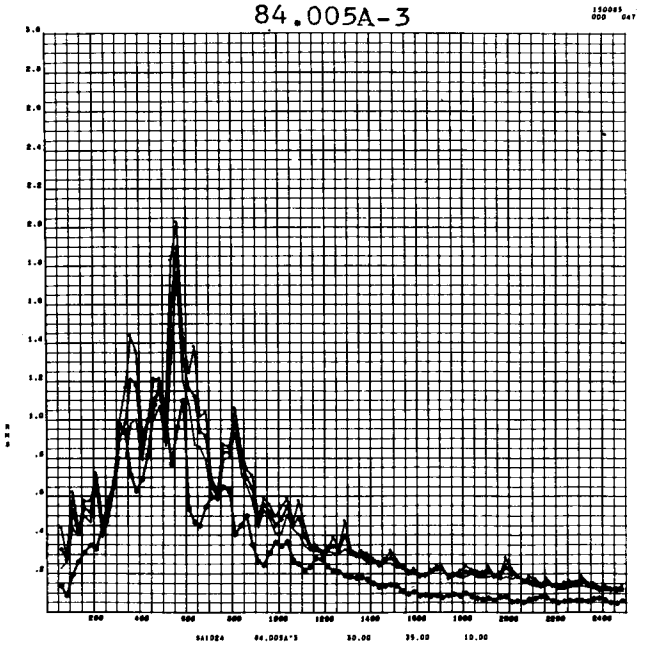
GRMS vs. FREQ

FIGURE B-97



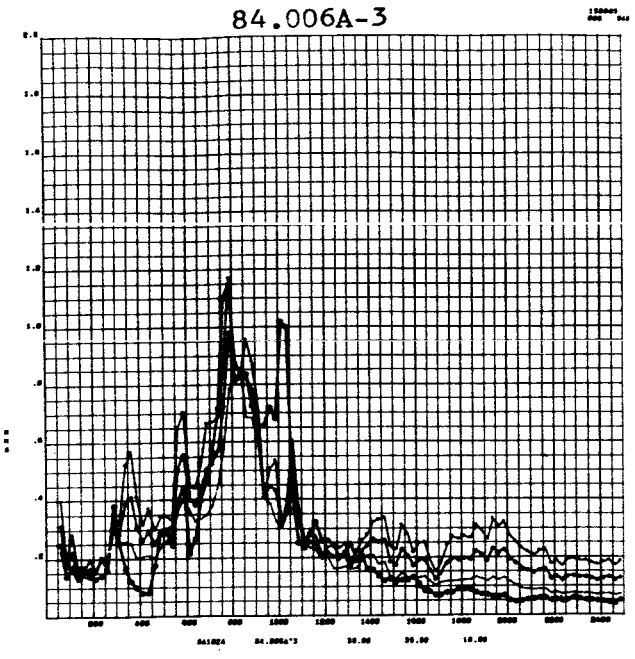
GRMS vs. FREQ.

FIGURE B-98



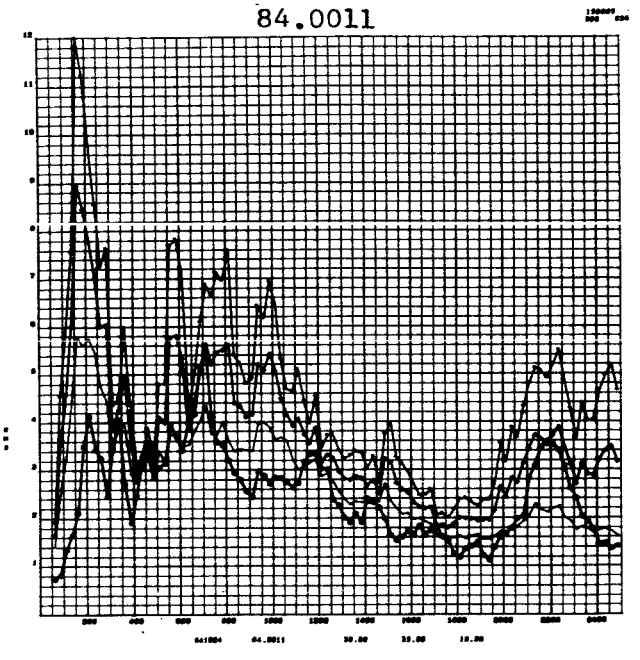
GRMS vs. FREQ

FIGURE B-99



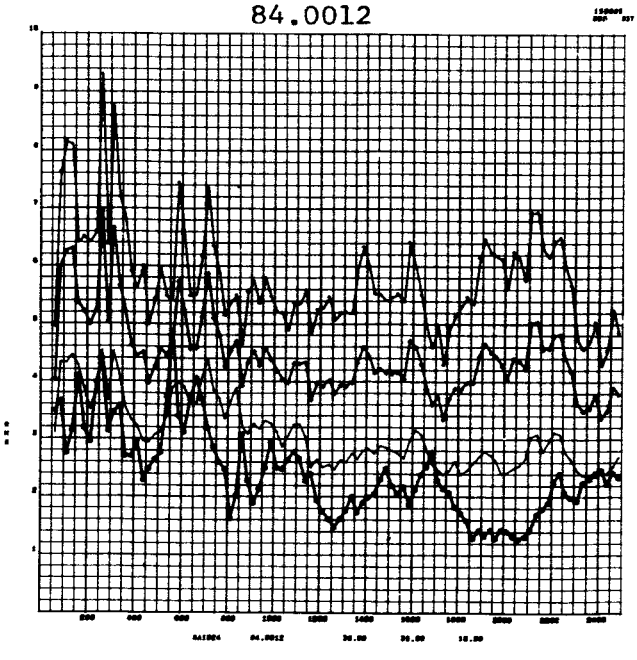
G_{RMS} vs. FREQ.

FIGURE B-100



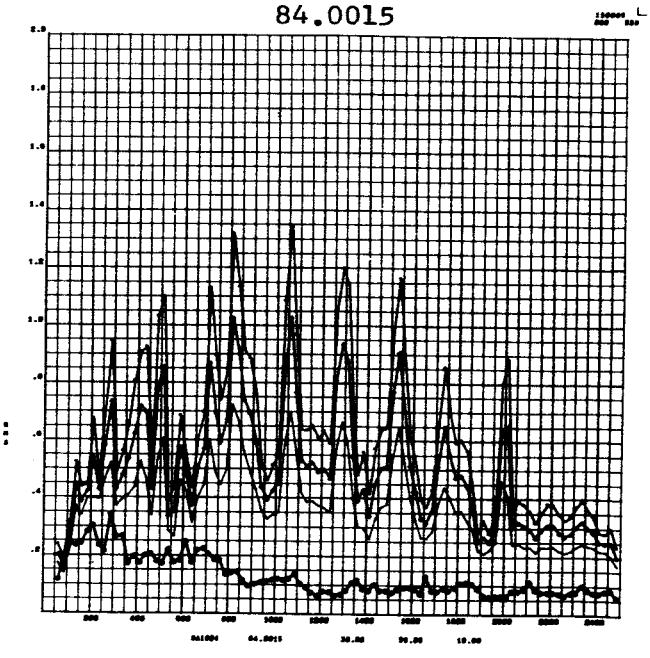
G_{RMS} vs. FREQ.

FIGURE B-101



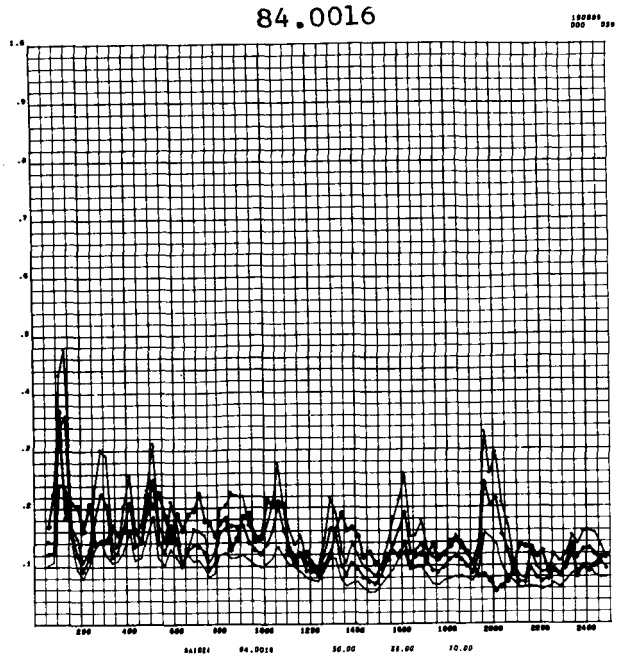
G_{RMS} vs. FREQ.

FIGURE B-102



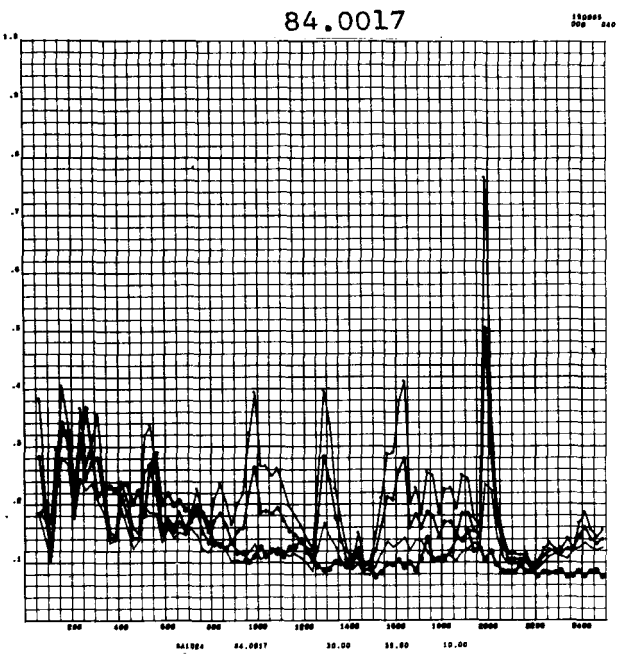
G_{RMS} vs. FREQ.

FIGURE B-103



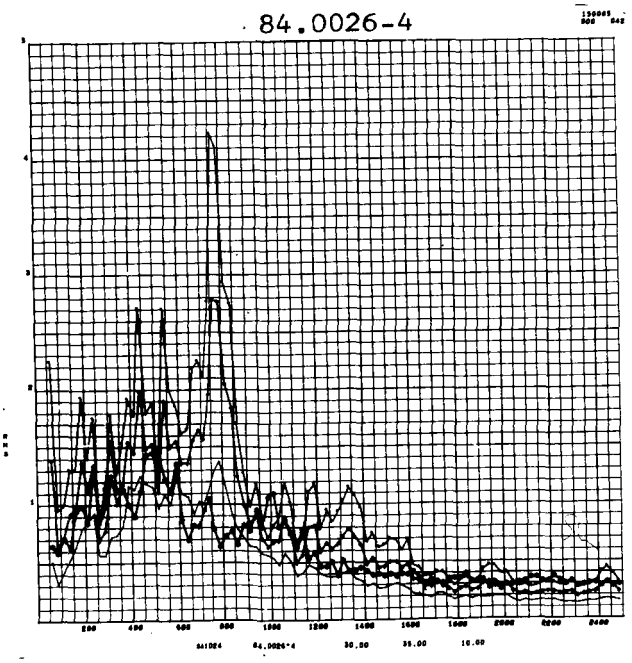
G_{RMS} vs. FREQ.

FIGURE B-104



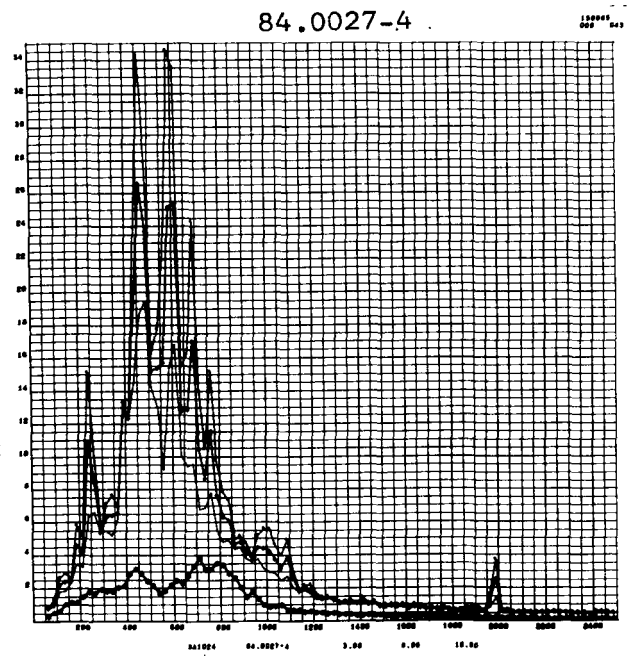
G_{RMS} vs. FREQ.

FIGURE B-105



G_{RMS} vs. FREQ.

FIGURE B-106



G_{RMS} vs. FREQ.

FIGURE B-107

APPENDIX C

TABLES

I. Data Acquisition and Data Reduction Systems Flow Charts

II. Hardwire Composite Vibration Levels

   a. Composite Engine Vibrations
   b. Composite R&D Vibration Levels

III. Static Test Measurement Discrepancies

IV. Instrumentation

   a. Hardwire
   b. Telemetry

TABLE Ia. Telemetered Data Acquisition and Data Reduction Flow Chart

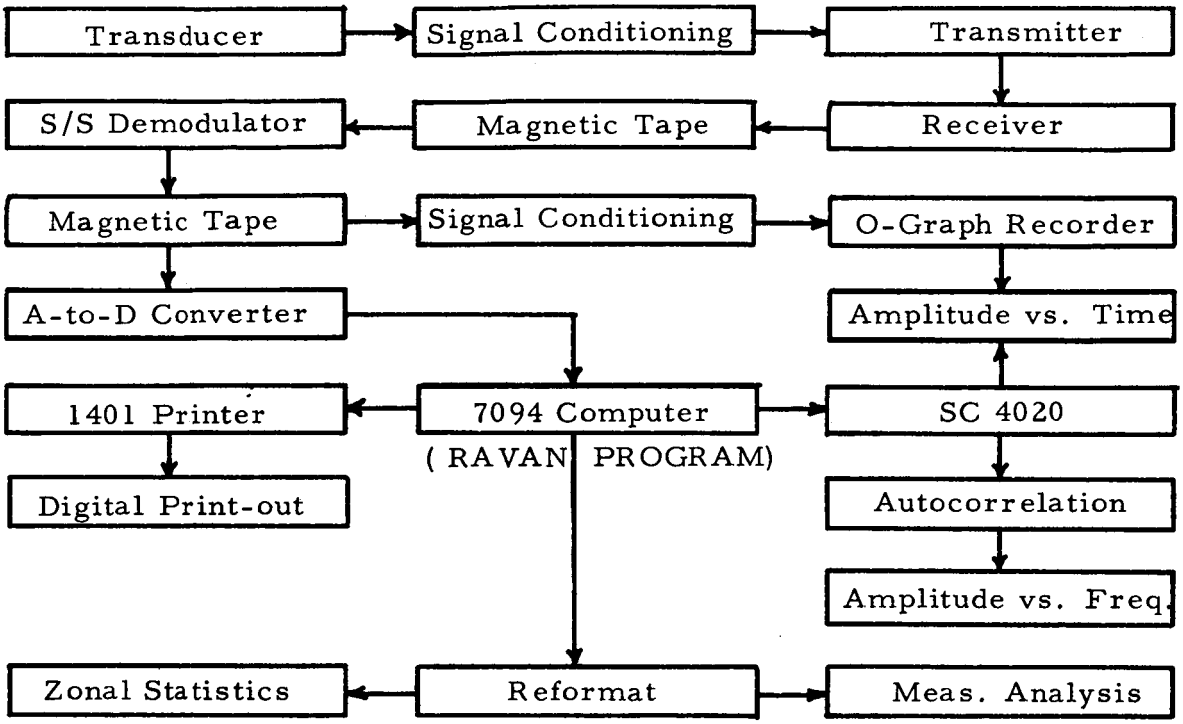


TABLE Ib. Hardwire Data Acquisition and Data Reduction Flow Chart

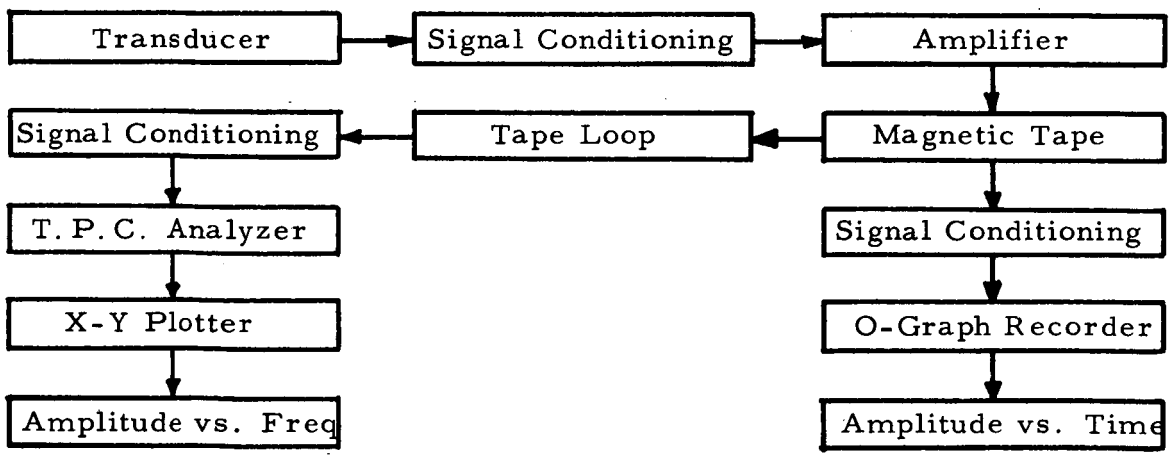


TABLE II-a
COMPOSITE ENGINE VIBRATIONS
G_{rms}, 0-5 kc

TEST SA-23
Slice Time X + 20-25 Seconds

STATIC MEAS. NO.	DESCRIPTION	ENG 1	ENG 2	ENG 3	ENG 4	ENG 5	ENG 6	ENG 7	ENG 8
81.041	Emergency RCC	8	8	7	8	8	8	8	8
82.03A	Gearcase Longitudinal, Fuel	12	13	13	16	14	12	13	12
82.03D	Gearcase Longitudinal, LOX	13	14	11	25	22	12	9	15

TEST SA-24
Slice Time X + 30-35 Seconds

STATIC MEAS. NO.	DESCRIPTION	ENG 1	ENG 2	ENG 3	ENG 4	ENG 5	ENG 6	ENG 7	ENG 8
81.041	Emergency RCC	7	6	6	7	*	6	7	7
82.03A	Gearcase Longitudinal, Fuel	15	19	13	19	15	13	19	13
82.03D	Gearcase Longitudinal, LOX	15	16	11	24	21	17	13	17

*Measurement was lost at X+3 seconds due to a defective transducer connecting cable.

TABLE II-b
COMPOSITE R&D VIBRATION LEVELS

G_{rms}

STATIC MEAS. NO	0-100 cps	0-2500 cps	0-5000 cps
81.300-4		7	7
81.301-4		9	10
81.302-4		7	7
81.303-4		11	12
81.304-4		12	14
81.305-4		11	11
81.306-8		11	11
81.307-8		19	20
81.308-8		12	13
81.309-8		16	17
81.310-8		22	23
81.311-8		17	17
84.001-3	0.5		
84.001A-3		16	16
84.002-3	2.0		
84.002A-3		11	11
84.003-4	0.9		
84.003A-4		35	36
84.004-4	1.7		
84.004A-4		19	19
84.005-3	0.6		
84.005A-3		6	6
84.006A-3		5	6
84.007-3	0.9		
84.008-3	1.0		
84.009-4	1.8		
84.0011		40	43
84.0012		40	41
84.0014		9	9
84.0015		2	3
84.0016		1	2
84.0017		1	2
84.0024-4	2.0		
84.0026-4		9	9
84.0027-4		44	44

The values tabulated are the maximum obtained on either SA-23 or SA-24.

TABLE II-b (Continued)

STATIC MEAS. NO	0-100 cps	0-2500 cps	0-5000 cps
84.999		13	44
84.9991		7	19
86.32		63	75
86.33		58	72
86.34		70	70
88.011		1	1
88.012		2	1
88.013		1	1
88.014		2	3
88.015		3	3
88.016		3	3
89.601		1	2
89.602		4	5
89.603		4	4
89.604		6	6
89.605		7	7
89.606		5	6
89.607		7	8
89.60	0.2		
89.61	0.1		

The values tabulated are the maximum obtained on either SA-23 or SA-24.

TABLE III

STATIC TEST MEASUREMENT DISCREPANCIES

MEASUREMENT NUMBER	TEST NUMBER SA-23	SA-24	DISCREPANCY (See Notes)
E11-2	X	X	5, 8
E11-4	X	X	1, 5, 8
E11-6	X		1, 7
E12-2	X		6, 7
E12-3	X		6, 7
E33-1	X	X	1, 5, 8
E33-3	X	X	1, 5, 8
E33-5	X	X	5, 8
E33-7	X	X	1, 5, 8
E139-9	X		6, 7
L28-9	X	X	1, 5
84.0013	X	X	2, 6, 7, 10
81.041-5		X	4, 6, 7
84.0017	X	X	3, 6, 7
84.0024-4	X		9
84.0027-4		X	2, 6, 7

NOTES:

1. Transients present in data.

TABLE III (Continued)

2. Transducer separated from structure, ineffective bonding.
3. Equipment overloaded.
4. Defective transducer connecting cable.
5. Data are presented for comparisons although considered invalid.
6. Data considered invalid.
7. No data analysis plots available.
8. Abnormally high amplitudes.
9. Patching error.
10. Deleted from test SA1024.

TABLE IV. a

INSTRUMENTATION-HARDWIRE

MEASUREMENT NUMBER	TRANSDUCER TYPE	TRANSDUCER MODEL	SYSTEM CALIBRATION	SYSTEM RESPONSE (cps)
81.041-1	Cubic	2A507	50 G_{rms}	5000
81.041-2	Cubic	2A507	50 G_{rms}	5000
81.041-3	Cubic	2A507	50 G_{rms}	5000
81.041-4	Cubic	2A507	50 G_{rms}	5000
81.041-5	Cubic	2A507	50 G_{rms}	5000
81.041-6	Cubic	2A507	50 G_{rms}	5000
81.041-7	Cubic	2A507	50 G_{rms}	5000
81.041-8	Cubic	2A507	50 G_{rms}	5000
82.03A-1	Cubic	2A507	100 G_{rms}	5000
82.03A-2	Cubic	2A507	100 G_{rms}	5000
82.03A-3	Cubic	2A507	100 G_{rms}	5000
82.03A-4	Cubic	2A507	100 G_{rms}	5000
82.03A-5	Cubic	2A507	100 G_{rms}	5000
82.03A-6	Cubic	2A507	100 G_{rms}	5000
82.03A-7	Cubic	2A507	100 G_{rms}	5000
82.03A-8	Cubic	2A507	100 G_{rms}	5000
82.03D-1	Cubic	2A507	100 G_{rms}	5000
82.03D-2	Cubic	2A507	100 G_{rms}	5000

TABLE IV. a (Continued)

MEASUREMENT NUMBER	TRANSDUCER TYPE	TRANSDUCER MODEL	SYSTEM CALIBRATION	SYSTEM RESPONSE (cps)
82.03D-3	Cubic	2A507	100 G_{rms}	5000
82.03D-4	Cubic	2A507	100 G_{rms}	5000
82.03D-5	Cubic	2A507	100 G_{rms}	5000
82.03D-6	Cubic	2A507	100 G_{rms}	5000
82.03D-7	Cubic	2A507	100 G_{rms}	5000
82.03D-8	Cubic	2A507	100 G_{rms}	5000
81.300-4	Glennite	A45U	10 G_{rms}	5000
81.301-4	Glennite	A45U	20 G_{rms}	5000
81.302-4	Glennite	A45U	20 G_{rms}	5000
81.303-4	Glennite	A45U	30 G_{rms}	5000
81.304-4	Glennite	A45U	30 G_{rms}	5000
81.305-4	Glennite	A45U	30 G_{rms}	5000
81.306-8	Glennite	A45U	30 G_{rms}	5000
81.307-8	Glennite	A45U	30 G_{rms}	5000
81.308-8	Glennite	A45U	30 G_{rms}	5000
81.309-8	Glennite	A45U	50 G_{rms}	5000
81.310-8	Glennite	A45U	50 G_{rms}	5000
81.311-8	Glennite	A45U	50 G_{rms}	5000
84.001-3	Statham	A6-15-350	5 G_{rms}	100

TABLE IV. a (Continued)

MEASUREMENT NUMBER	TRANSDUCER TYPE	TRANSDUCER MODEL	SYSTEM CALIBRATION	SYSTEM RESPONSE
84.001A-3	Cubic	2A507	40 G_{rms}	5000
84.002-3	Statham	A6-15-350	5 G_{rms}	100
84.002A-3	Cubic	2A507	10 G_{rms}	5000
84.003-4	Statham	A6-15-350	5 G_{rms}	100
84.003A-4	Cubic	2A507	5 G_{rms}	5000
84.004-4	Statham	A6-15-350	5 G_{rms}	100
84.004A-4	Cubic	2A507	5 G_{rms}	5000
84.005-3	Statham	A6-15-350	5 G_{rms}	100
84.005A-3	Cubic	2A507	10 G_{rms}	5000
84.006A-3	Cubic	2A507	10 G_{rms}	5000
84.007-3	Statham	A6-15-350	5 G_{rms}	100
84.008-3	Statham	A6-15-350	5 G_{rms}	100
84.009-4	Statham	A6-15-350	10 G_{rms} (SA1023) 5 G_{rms} (SA1024)	100 100
84.0011	Cubic	2A507	75 G_{rms}	5000
84.0012	Cubic	2A507	75 G_{rms}	5000
84.0013	Cubic	2A507	50 G_{rms}	5000
84.0014	Cubic	2A507	20 G_{rms}	5000
84.0015	Glennite	A45U	10 G_{rms}	5000

TABLE IV. a (Continued)

MEASUREMENT NUMBER	TRANSDUCER TYPE	MODEL	SYSTEM CALIBRATION	RESPONSE (cps)
84.0016	Glennite	A45U	10 G_{rms}	5000
84.0017	Glennite	A45U	10 G_{rms}	5000
84.0024-4	Statham	A6-15-350	10 G_{rms}	100
84.0026-4	Cubic	2A507	20 G_{rms}	5000
84.0027-4	Cubic	2A507	100 G_{rms}	5000
84.999	Cubic	2A507	75 G_{rms}	5000
84.9991	Cubic	2A507	75 G_{rms}	5000
86.32	Cubic	3A509	100 G_{rms}	5000
86.33	Cubic	3A509	100 G_{rms}	5000
86.34	Cubic	3A509	100 G_{rms}	5000
88.011	Cubic	2A507	10 G_{rms}	5000
88.012	Cubic	2A507	10 G_{rms}	5000
88.013	Cubic	2A507	10 G_{rms}	5000
88.014	Glennite	A45U	20 G_{rms}	5000
88.015	Glennite	A45U	20 G_{rms}	5000
88.016	Glennite	A45U	20 G_{rms}	5000
89.601	Glennite	A45U	20 G_{rms}	5000
89.602	Glennite	A45U	20 G_{rms}	5000
89.603	Glennite	A45U	20 Grms (SA1023)	5000

TABLE IV. a (Contined)

MEASUREMENT NUMBER	TRANSDUCER TYPE	TRANSDUCER MODEL	SYSTEM CALIBRATION	SYSTEM RESPONSE (cps)
89.603	Glennite	A45U	10 G_{rms} (SA1024)	5000
89.604	Glennite	A45U	20 G_{rms}	5000
89.605	Glennite	A45U	20 G_{rms}	5000
89.606	Glennite	A45U	20 G_{rms}	5000
89.607	Cubic	2A507	50 G_{rms}	5000
89.60	Statham	A6-15-350	2 G_{rms}	100
89.61	Statham	A6-15-350	2 G_{rms}	100

TABLE IV. b

INSTRUMENTATION-TELEMETRY

MEASUREMENT NUMBER	TRANSDUCER TYPE	TRANSDUCER MODEL	SYSTEM CALIBRATION	SYSTEM RESPONSE (cps)
E11-2	Gulton	TA501UA	± 50 G	2500
E11-4	Gulton	TA501UA	± 50 G	2500
E11-6	Gulton	TA501UA	± 50 G	2500
E11-8	Gulton	TA501UA	± 50 G	2500
E12-1	Gulton	TA501UA	± 50 G	2500
E12-2	Gulton	TA501UA	± 50 G	2500
E12-3	Gulton	TA501UA	± 50 G	2500
E12-4	Gulton	TA501UA	± 50 G	2500
E12-5	Gulton	TA501UA	± 50 G	2500
E12-6	Gulton	TA501UA	± 50 G	2500
E12-7	Gulton	TA501UA	± 50 G	2500
E12-8	Gulton	TA501UA	± 50 G	2500
E33-1	Glennite	AT1289	± 50 G	2500
E33-3	Glennite	AT1289	± 50 G	2500
E33-5	Glennite	AT1289	± 50 G	2500
E33-7	Glennite	AT1289	± 50 G	2500
E105-11	Glennite	AT1289	± 25 G	2500
E107-11	Glennite	AT1289	± 25 G	2500

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